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C-H

CUTLER-HAMMER

ELECTRIC ELEVATOR CONTROLLERS

NOV 12 '24

CUTLER-HAMMER ELECTRIC ELEVATOR CONTROL EQUIPMENT

C-H

Publication 3082

THE CUTLER-HAMMER MFG. CO.

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The illustration below shows a typical installation of Cutler-Hammer elevator controllers in a modern office building. The installation consists of eight Bulletin 7331 controllers for operating high-speed passenger elevators.

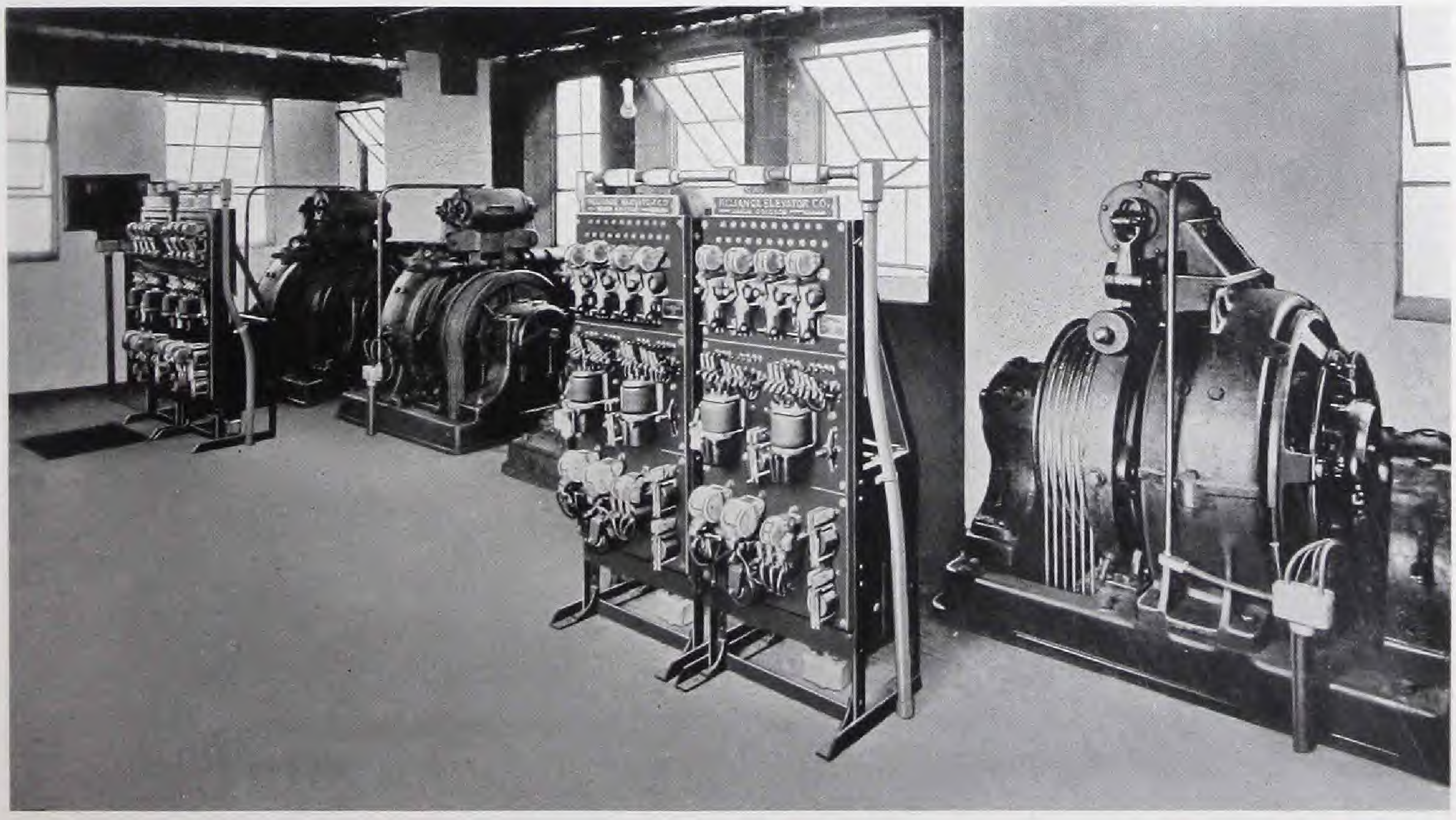
NATIONAL CITY CO.
BUILDING
New York City

Cutler-Hammer Elevator Controllers

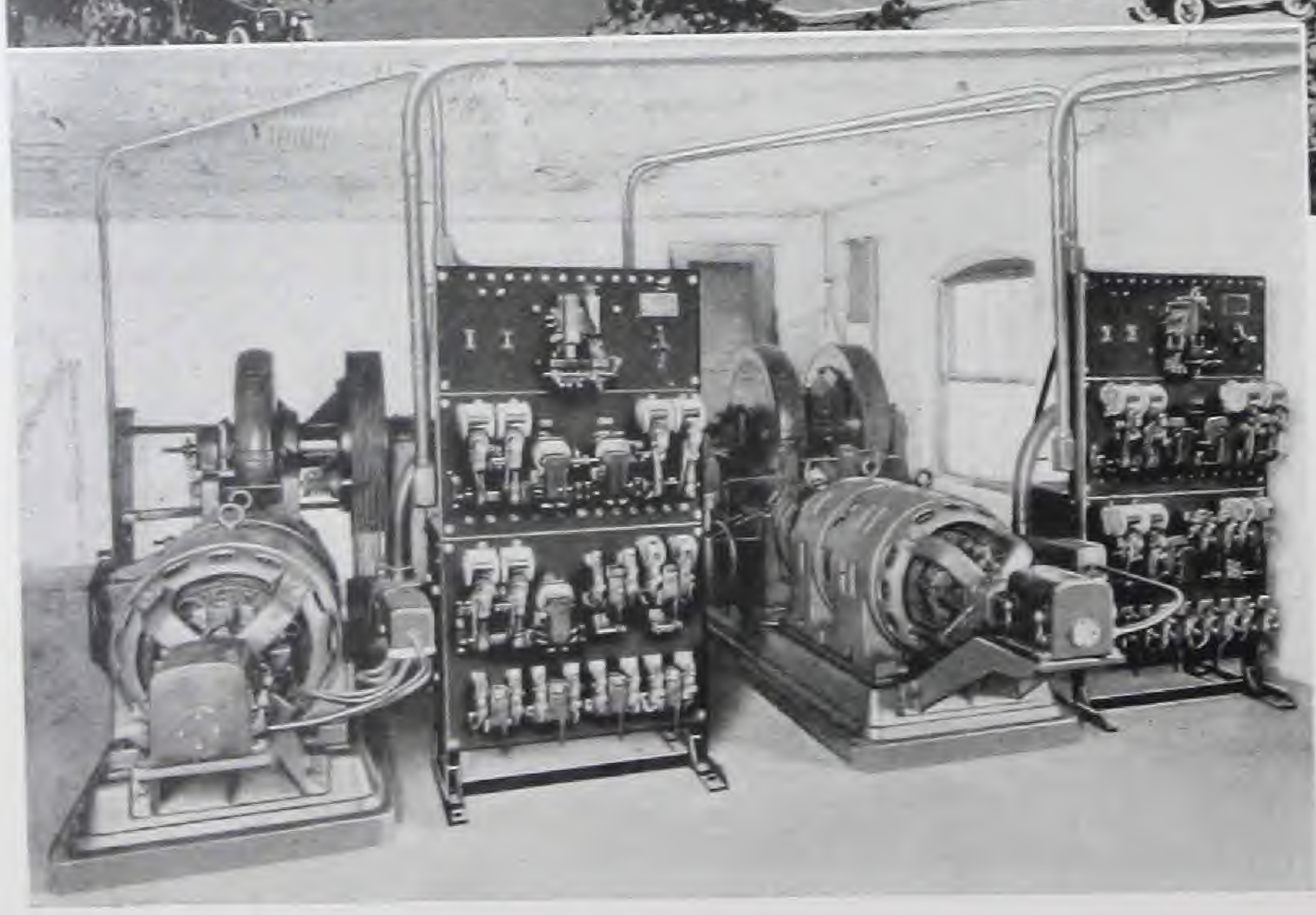
EVERY C-H Elevator Controller is more than a well-arranged collection of contactors, resistance grids and accessories. It is the outcome of the accumulated knowledge of over twenty-five years. These years have demonstrated how important a part the controller plays in the safety of the elevator, how carefully the design must be studied to secure smooth acceleration and deceleration under all circumstances, and how essential it is to use simple, sturdy controller parts to prevent annoying delays for adjustments and renewals. No matter how efficient the motor or how well designed the elevator machine, it is only through the controller that these valuable characteristics are properly co-ordinated and made available.

The salient features of Cutler-Hammer Elevator Controllers are: Renewable carbon-to-copper power contacts; a simple constant-time-limit type of acceleration; unusually quiet, sure-operating magnetic contactors; and simple dependable construction with few auxiliary interlocking contacts. Careful workmanship and excellence of material are features which have always characterized C-H Elevator Controllers.

Carbon-to-copper power contacts have been made standard equipment on all C-H Elevator Controllers because of the exceptional safety which they provide. Carbon-to-copper contacts positively cannot weld and prevent the motor from being disconnected from the line. These contacts are interchangeable on either direct or alternating-current contactors of comparable sizes. Experience has also demonstrated that two sizes of contacts, nominally rated at 100 and 200 amperes for intermittent elevator service, will handle all usual sizes of elevator controllers. Elevator manufacturers and jobbers are thus relieved of some of their overhead burden. For about half their former investment, they can keep an ample supply of contacts on hand for



Installation of C-H Variable-Voltage Controllers for the Operation of Passenger Elevators at a Maximum Speed of 600 Feet per Minute. These Controllers Accelerate and Decelerate the Elevators with the Highest Degree of Smoothness



BELDEN HOTEL
Chicago

This modern apartment building is equipped with Cutler-Hammer controllers. At the left are shown two of the two-speed alternating-current passenger elevator controllers (Bulletin 9872) with dynamic braking governors, while the insert shows one of the freight-elevator controllers.

customers using either direct or alternating-current service.

Power contacts of both sizes are easily and quickly renewed, when worn out, at slight expense. Power contacts of the 200-ampere size are provided with suitable adjustments for taking care of fully $\frac{3}{8}''$ of wear. In the 100-ampere size the copper contacts are of the drum finger type and the contact spring takes care of the wear. Both sizes are generously rated and long-lived. The long life is due primarily to the low contact temperature which is secured by using stronger contact pressure than is usually considered necessary. The firm, positive operating characteristics of C-H Contactors also have their effect in making the wear on the contacts slow and even.

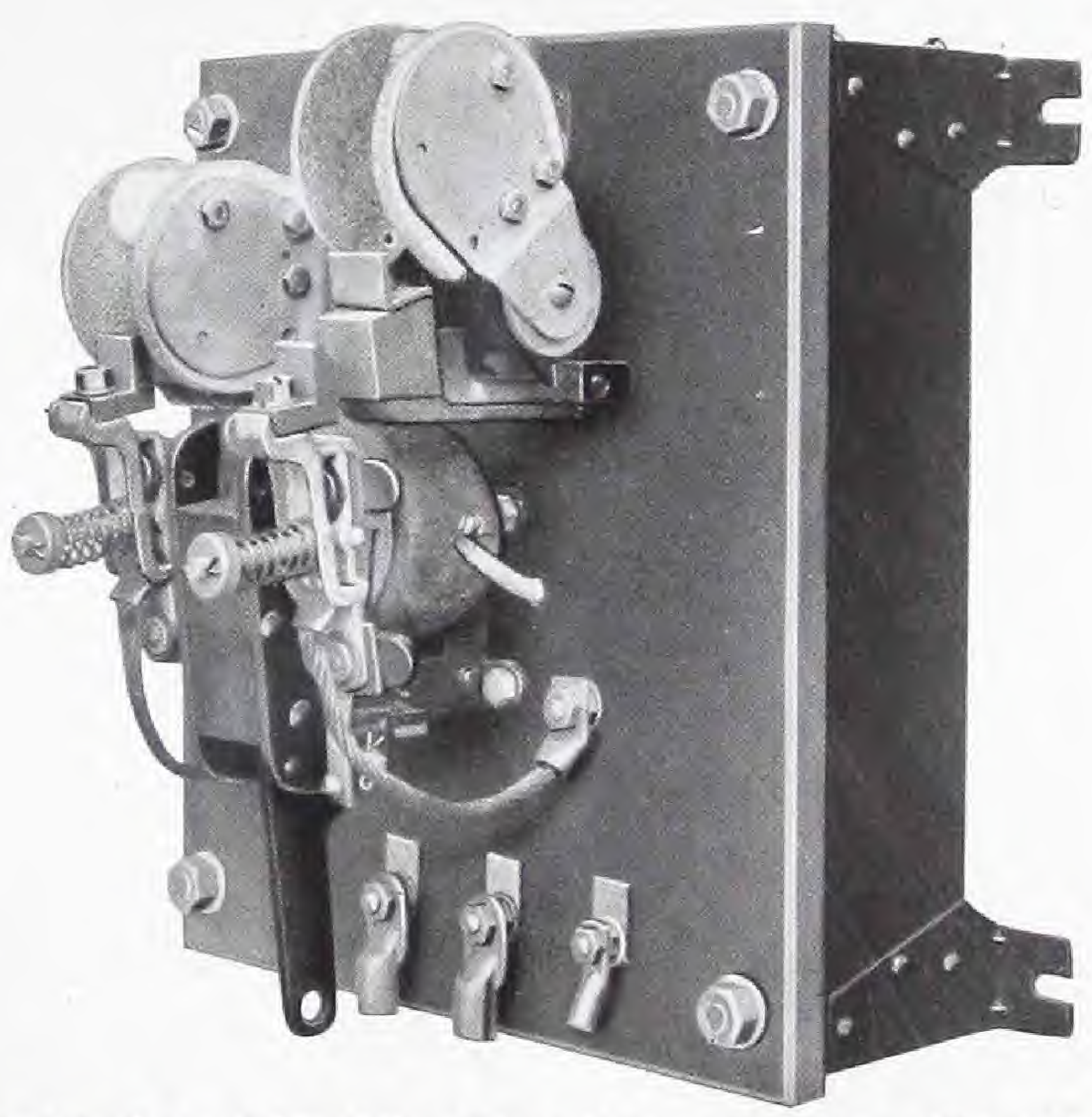
Carbon-to-Copper Contacts, the Substantial Construction of Which Insures Uniform Wear and Long Life

Powerful magnetic blowouts of efficient design are used on main magnetic contactors. The controllers used with drum type reversing switches are so arranged that the arcing is handled by the main contactors, thus relieving the reversing switches of this duty and prolonging the life of the equipment.

C-H constant-time-limit acceleration has been standardized as the most suitable for elevator service. Time of acceleration is easily adjusted to suit operating conditions and this adjustment is maintained indefinitely. Constant-time-limit acceleration eliminates most of the auxiliary contacts which are required with other types of acceleration, and simplifies the entire controller. Moreover, this method of acceleration furnishes the same comfortable smoothness in spite of widely varying load conditions. The very simplicity of C-H time-limit acceleration is a big advantage because of the fact that so much of the elevator maintenance work is in the hands of men who may not be thoroughly familiar with the principles underlying elevator operation. The energizing solenoid is also of sufficient size to do away with any current-limiting resistor in the solenoid circuit after the plunger has completed its travel.

Frame of a 200-Ampere, Double-Pole Contactor Magnet, Showing How Removal of Spacer Allows the Clapper to Drop Back for Ready Access to the Coil

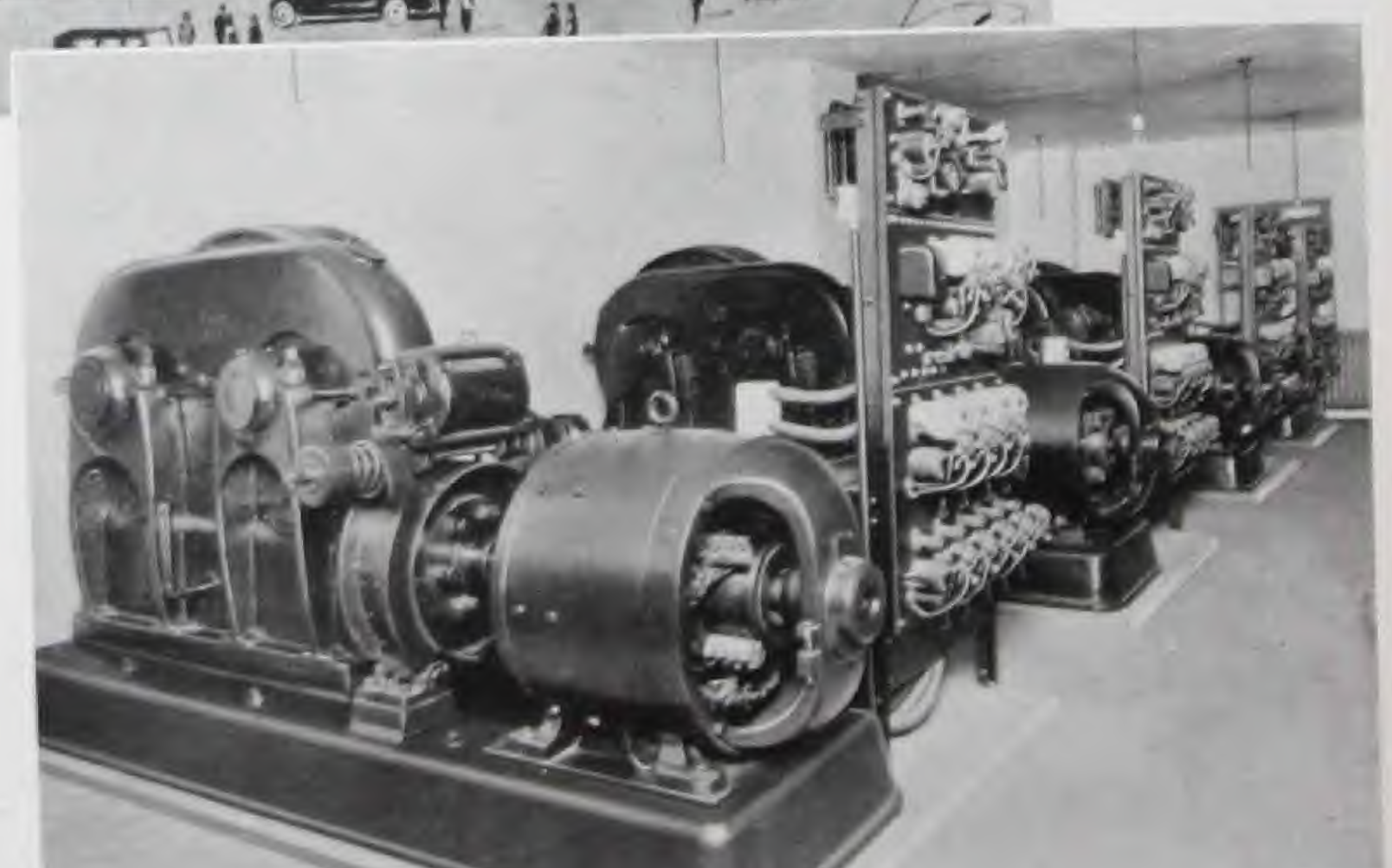
The oil dashpot used on C-H accelerating devices is so constructed that there is nothing to get out of order or cause deterioration. The metal piston operates in a sealed pot. There is no splashing or leaking of oil. A sufficient quantity of oil for several fillings is supplied with each controller.



Double-Pole Magnetic Contactor with One Blow-Out Shield Raised to Show the Carbon-to-Copper Contacts

The conditions under which elevator controller contactors operate are exceptionally severe. "Inching" for landings is not uncommon even with experienced operators. Reversing the controller or "plugging" to secure quick stops is frequent. In spite of these conditions, C-H contactors require very little attention. They are designed and built for just such service.

C-H Magnetic Contactors for either direct or alternating-current service close with little noise. The alternating-current contactors do



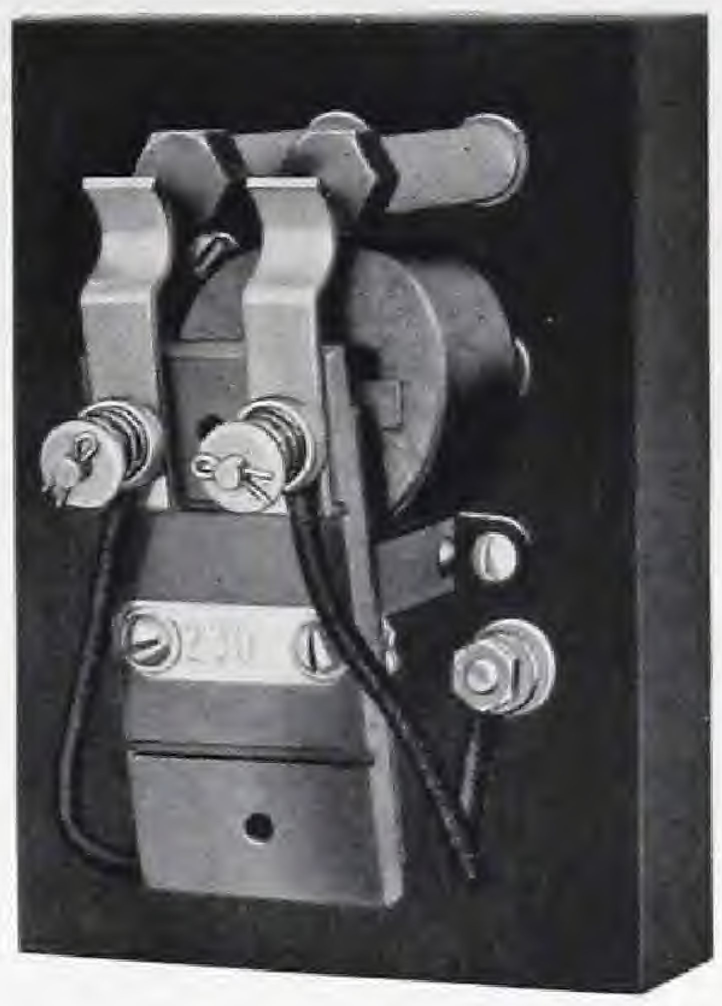
OLD COLONY LIFE BUILDING
Chicago

This installation consists of ten C-H controllers (Bulletin 7331) for operating high-speed elevators of the single-gear, V-groove traction type. These elevators have a maximum speed of 600 feet per minute.

not hum or chatter but close with a business-like click. All C-H Contactors are designed with a high sealing pull, which insures ample pressure to keep down the contact temperature.

Because of the fact that so much elevator maintenance is placed in the hands of general repair men, janitors and those who have comparatively little knowledge of such equipment, elevator builders have long sought to simplify elevator installations. C-H Elevator Controllers are designed with this idea in mind. They have very few interlocking contacts, due in part to their design, in part to the simple constant-time-limit type of acceleration, and in part to the use of mechanical interlocks in connection with reversing contactors. The lack of numerous interlocking contacts eliminates just that many possible sources of trouble and permits the location of any trouble much more readily. Less time is required to clear any difficulty.

C-H Controller Panels are all conveniently arranged for external wiring. On full magnetic controllers the controller terminals are located along the top of the board where there is sure to be ample room for conduit systems. Line and motor terminals, which require larger conduits,



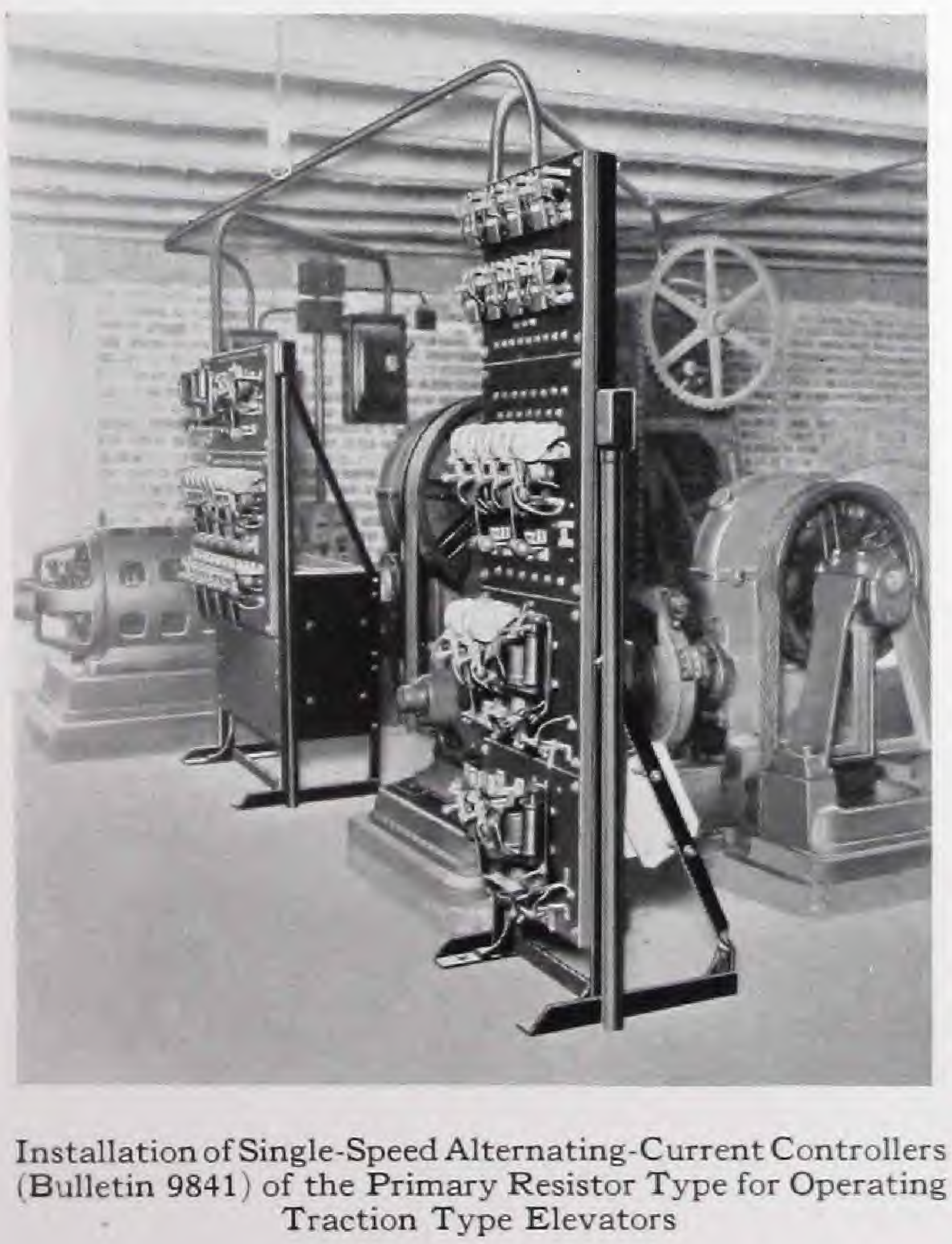
No. 230 Relay for Direct or Alternating-Current Automatic Elevator Service. Note the Extremely Simple and Durable Construction

are conveniently grouped at some point below the controller terminals.

Resistors used with C-H Elevator Controllers are usually mounted at the backs of the panels where they are out of the way. They are always made accessible for adjustments.

Full-Magnetic Elevator Controllers

Full-magnetic elevator control has in recent years been adopted as standard for installations

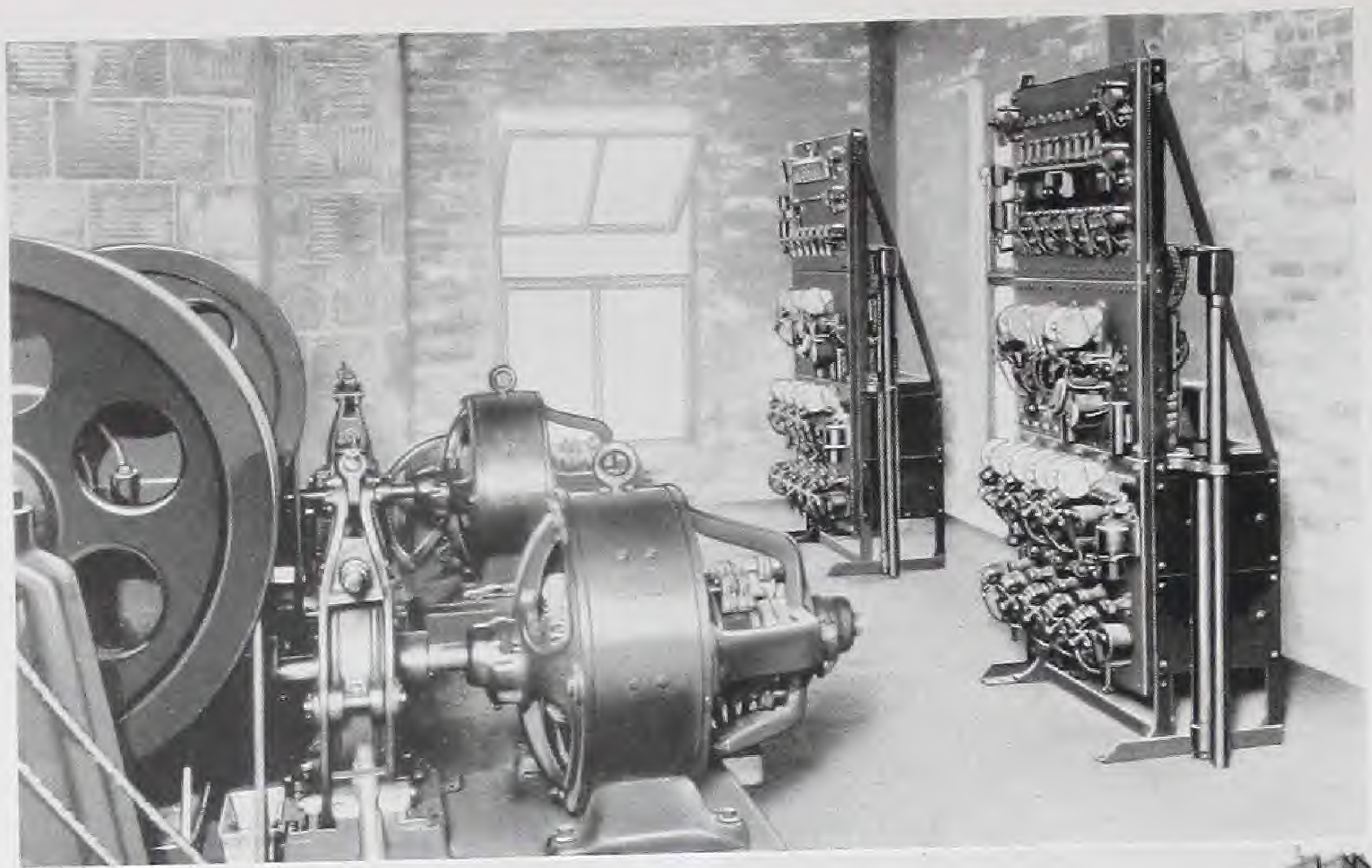


Installation of Single-Speed Alternating-Current Controllers (Bulletin 9841) of the Primary Resistor Type for Operating Traction Type Elevators

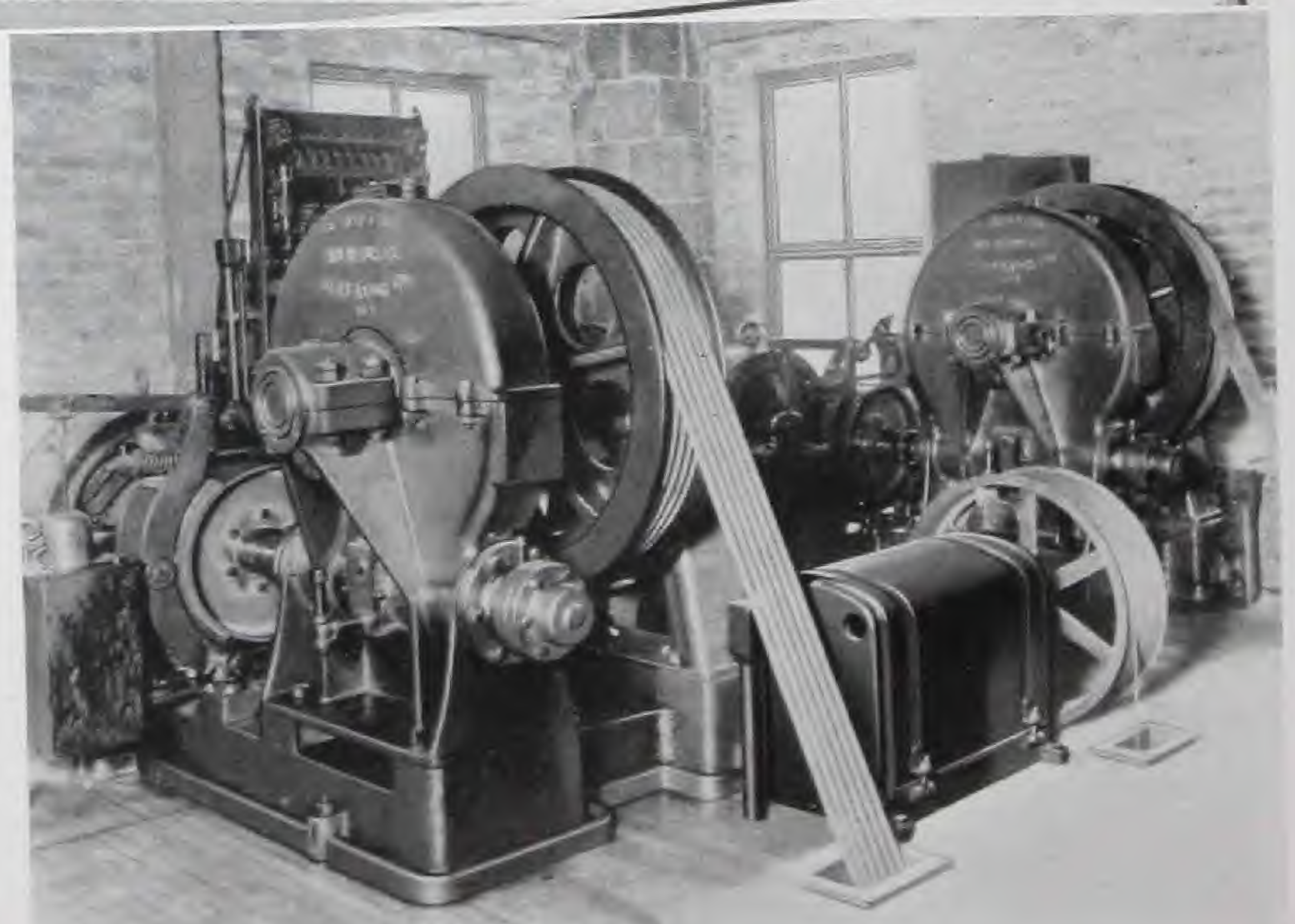
of any size or importance, because of the greater safety inherent in this type of control. Full-magnetic controllers may be arranged for either car-switch or push-button operation. For installations where it is not economical to employ an operator for the entire period of operation, the controller may be arranged for dual control.

C-H Full Magnetic Controllers provide low-voltage protection with push-button control. This prevents the elevator from starting automatically when the line voltage returns. One of the floor buttons must be pressed before the car will start after it has stopped because of voltage failure or for any other reason.

With car-switch control, low-voltage protection is not so essential. The car switch is self-centering. The operator's hand remains on the handle as long as it is in the "run" position. There is comparatively little danger that the car will start unexpectedly. Low-voltage protection may, however, be obtained in connection with a special sequence relay as an optional feature with car-switch control. Such a relay, in addition to providing low-voltage protection, obliges the operator to close the elevator door before he moves the car switch to the "run" position.



A typical installation of C-H dual-type controllers (Bulletin 7331) arranged for both car-switch and push-button operation.



MILWAUKEE CONTINUATION SCHOOL

View of the elevator motive equipment, showing C-H drum-type floor-selector device used for push-button operation of the slow-speed passenger elevators.

Slow-down and dynamic braking—features which assist the mechanical brake in stopping the elevator—may be obtained on all direct-current C-H Full-Magnetic Elevator Controllers. Both slow-down and dynamic braking are necessary on all high-speed equipments. They are essential on all installations requiring accurate stops, no matter what the speed.

Dynamic-braking action may be obtained on high-speed alternating-current full-magnetic controllers providing a two-speed motor is used. This type of motor is being manufactured by several of the leading motor builders and its entire practicability has been demonstrated. So far as is known, C-H Full-Magnetic Elevator Controllers, used in connection with two-speed motors, provide the only automatic "dynamic braking" feature for alternating-current service on the market. It does not matter how the car-switch control handle is manipulated, the dynamic-braking action is automatic and assists the mechanical brake in stopping the car.

Variable-Voltage Elevator Controllers

The variable-voltage elevator controller operates to change the voltage of the direct-current generator of a motor-generator set by field control, thus altering the speed of the elevator motor by varying the supply voltage. All operations of the elevator motor, such as starting, stopping, acceleration and deceleration, are accomplished by changing the excitation of the generator field.

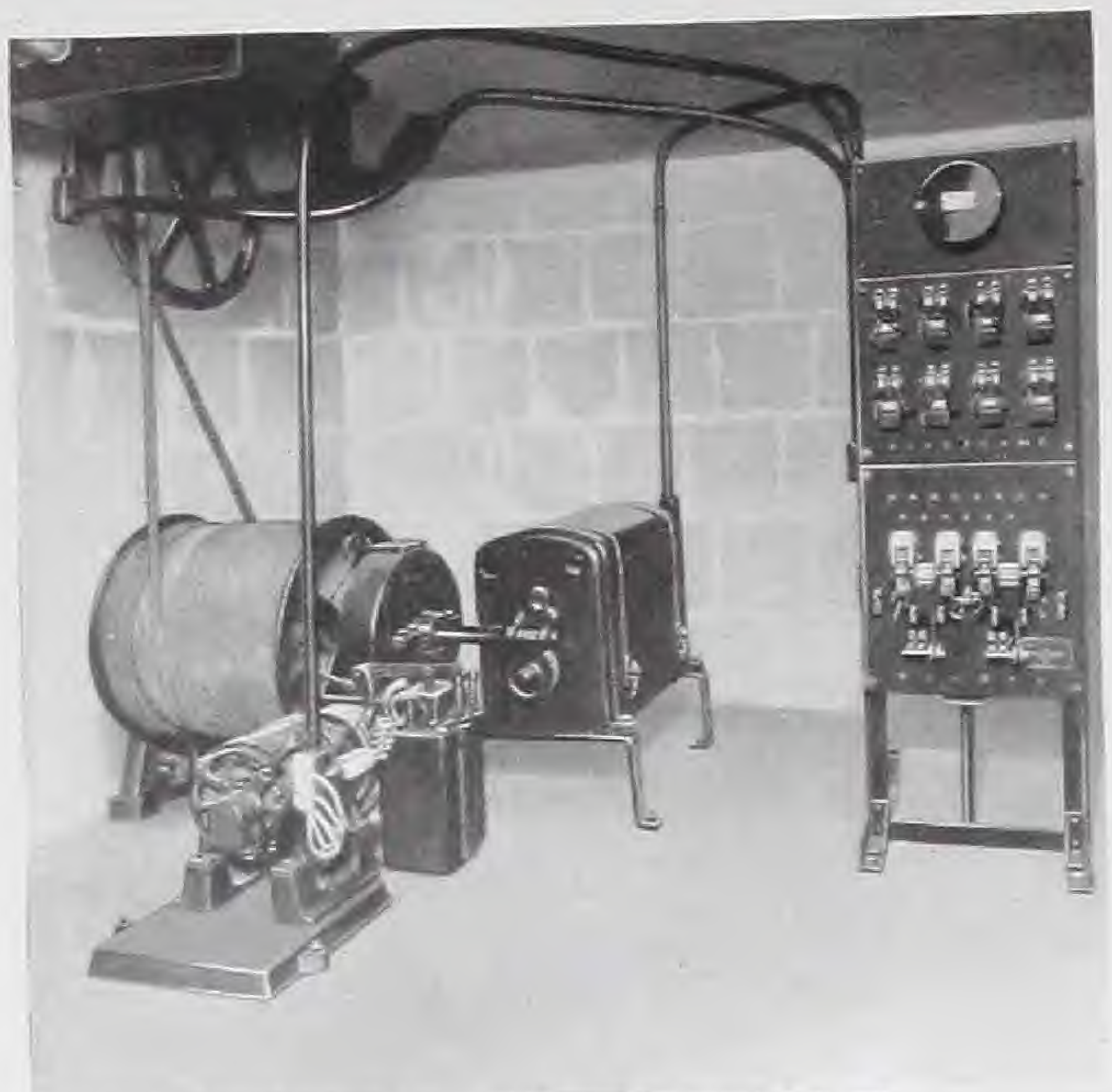
The apparatus required in addition to the elevator controller and motor is a motor-generator set, consisting of a main motor which may be either of the direct or alternating-current type, a direct-current generator and a starter for the main motor. The main motor is connected to the available source of supply through the starter and runs continuously whether the elevator is running or not, except when shut down for repairs or when out of service.

The C-H standard type "B" car switch is used and three speeds are provided in either direction. The first speed is very slow for the purpose of making accurate landings and the second speed is about one-half of full speed. The usual hoistway limit switches are required.

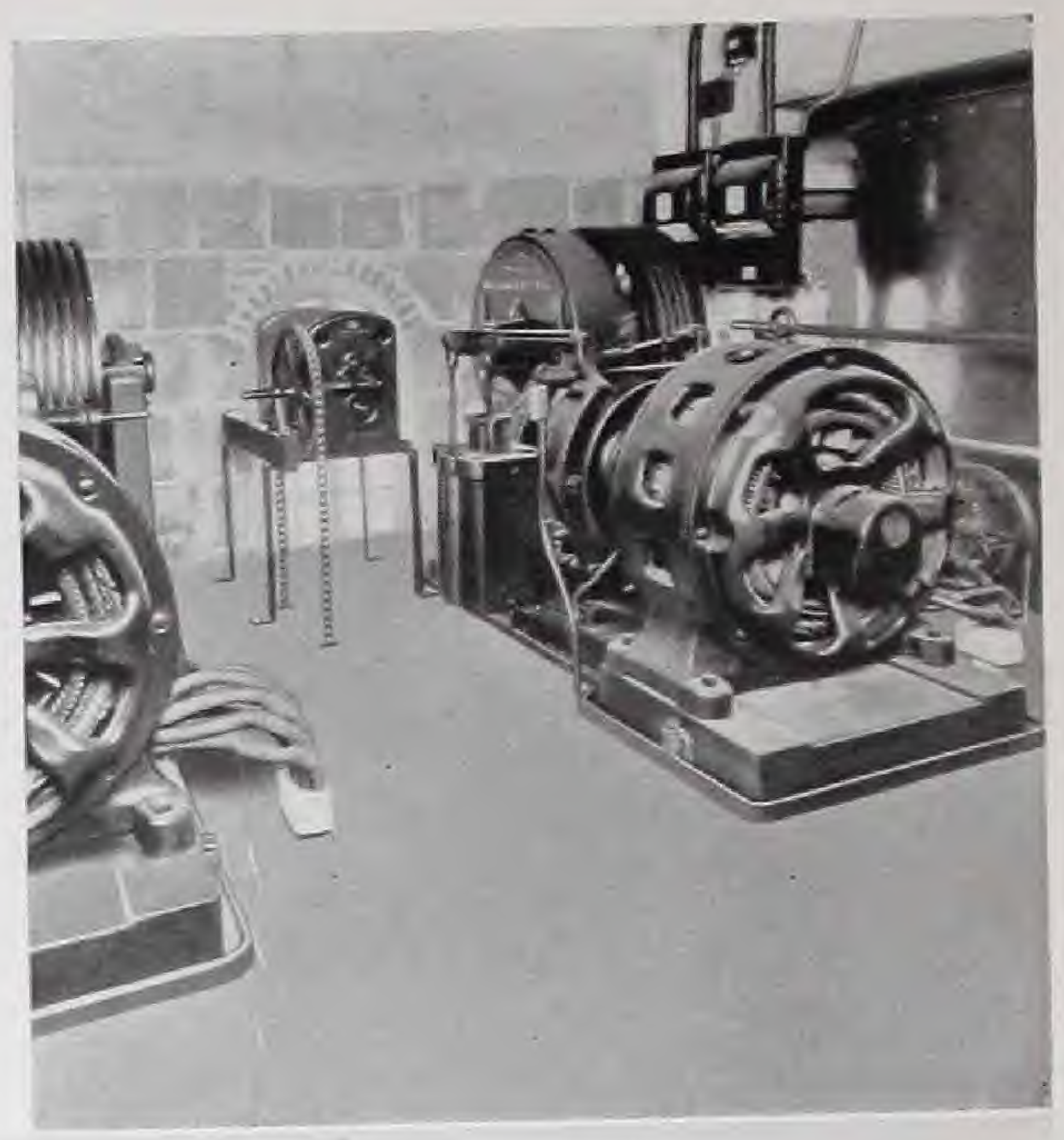
To operate the elevator the motor-generator set must first be put into operation. This is done by closing the knife switch to the main motor and operating the starter. The next step is to close all safety switches and then all other functions of operation are obtained by manipulating the car switch.

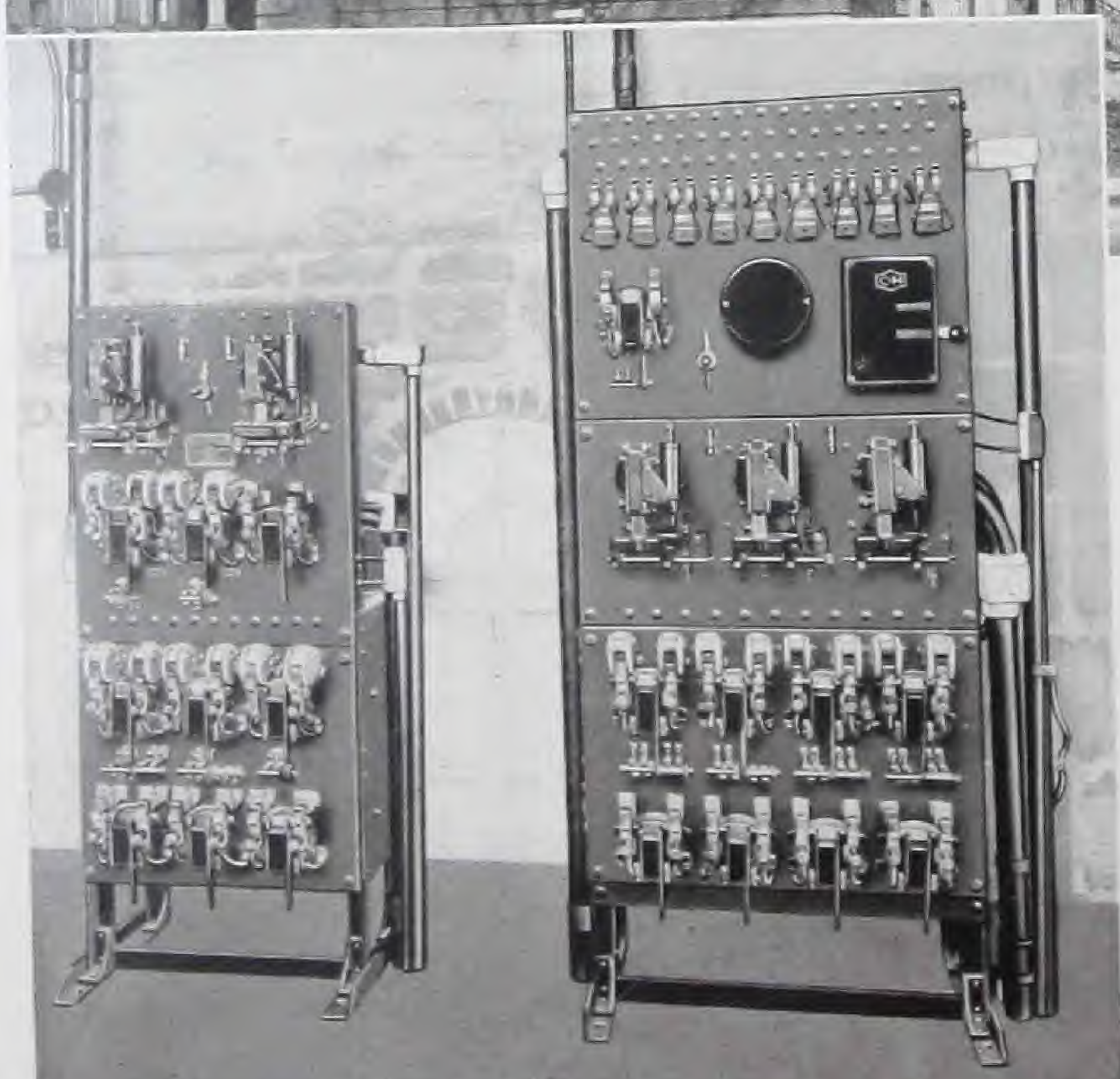
When the car switch is moved to the first-speed position, the field and brake relay and either the "up" or "down" direction contactors close, providing full field for the elevator motor, releasing the brake, and energizing the generator field with all of its field resistor in circuit. The field resistor is so designed that the voltage generated, when it is all in series with the field, will be such

Variable-Voltage Elevator Controller



MILWAUKEE CHILDREN'S HOSPITAL





At the left are shown the two-speed alternating-current car-switch and dual-type controllers (Bulletin 9843). Upper left shows the dumb-waiter controller (Bulletin 9841), and upper right shows the motors and drum-type floor-selector device for automatic control of one of the passenger elevators.

that with full load on the elevator car the elevator motor will turn over very slowly.

In the second-speed position of the car switch, the first field relay is energized and operates gradually to short out five steps of field resistor. The time required depends upon the oil dash-pot, which is used to retard the closure of this field relay. The voltage then generated is sufficient to operate the elevator at one-half its full speed.

With the car switch in the third-speed position, a second field relay similar to the first is energized and this operates to gradually short out the remainder of the field resistor so that the elevator car accelerates smoothly to full speed. While running at full speed the operator may move the car switch back to any position, and the elevator car will automatically decelerate to the speed corresponding to the position of the car switch.

In case the operator moves the car switch from the full speed to the "off" position, or full speed in the other direction, the relays and contactors on the controller will automatically operate in the proper sequence due to interlocks, and the elevator car will decelerate, stop or accelerate without a jerk.

Over-speed of the elevator motor on an overhauling load is prevented by a compound-wound relay, which operates to insert resistance in series with the generator field, thus reducing the voltage and causing the motor to slow down.

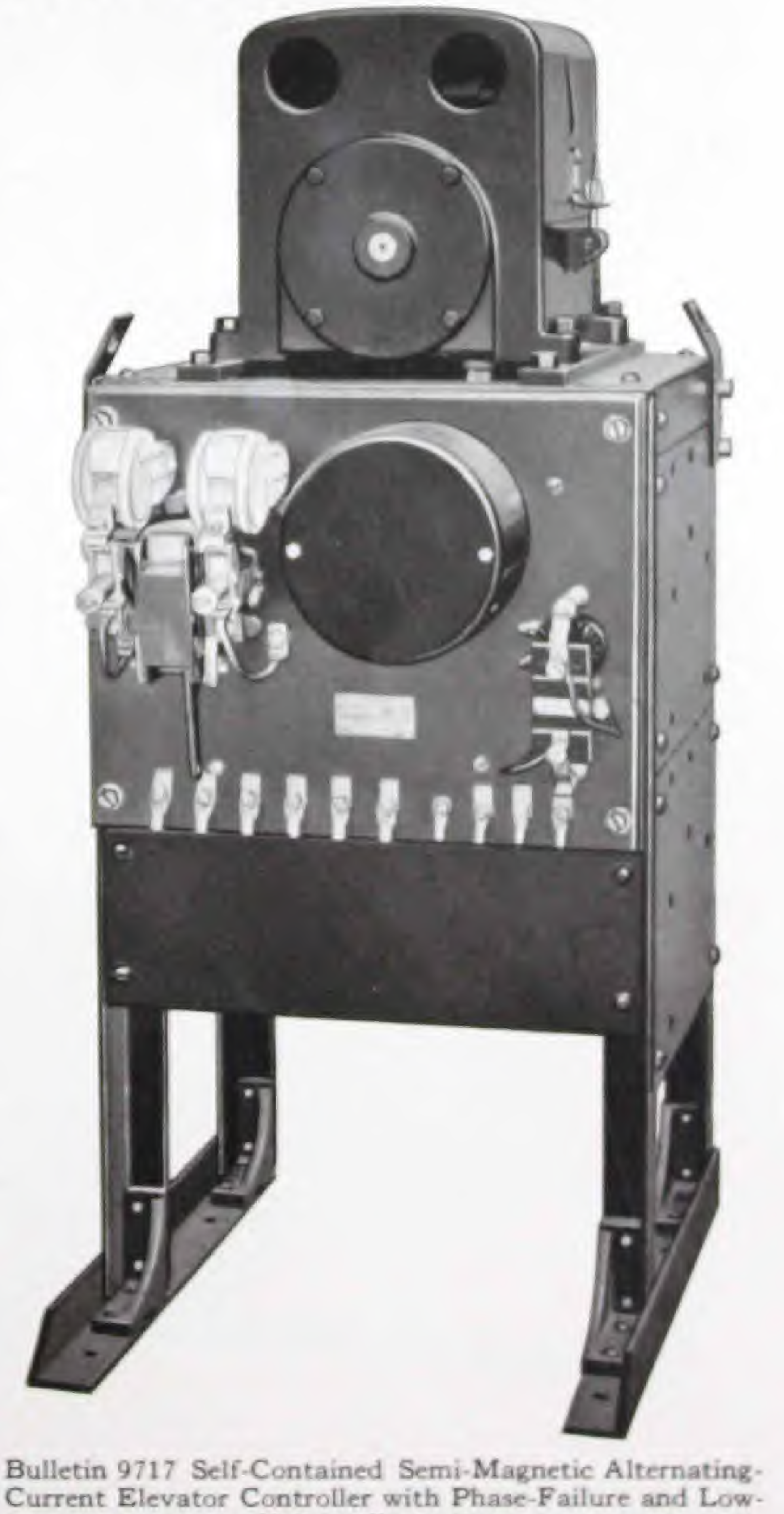
Semi-Magnetic Elevator Controllers

Semi-magnetic control is suited only for slow-speed elevators and is in practice confined chiefly to freight elevator service.

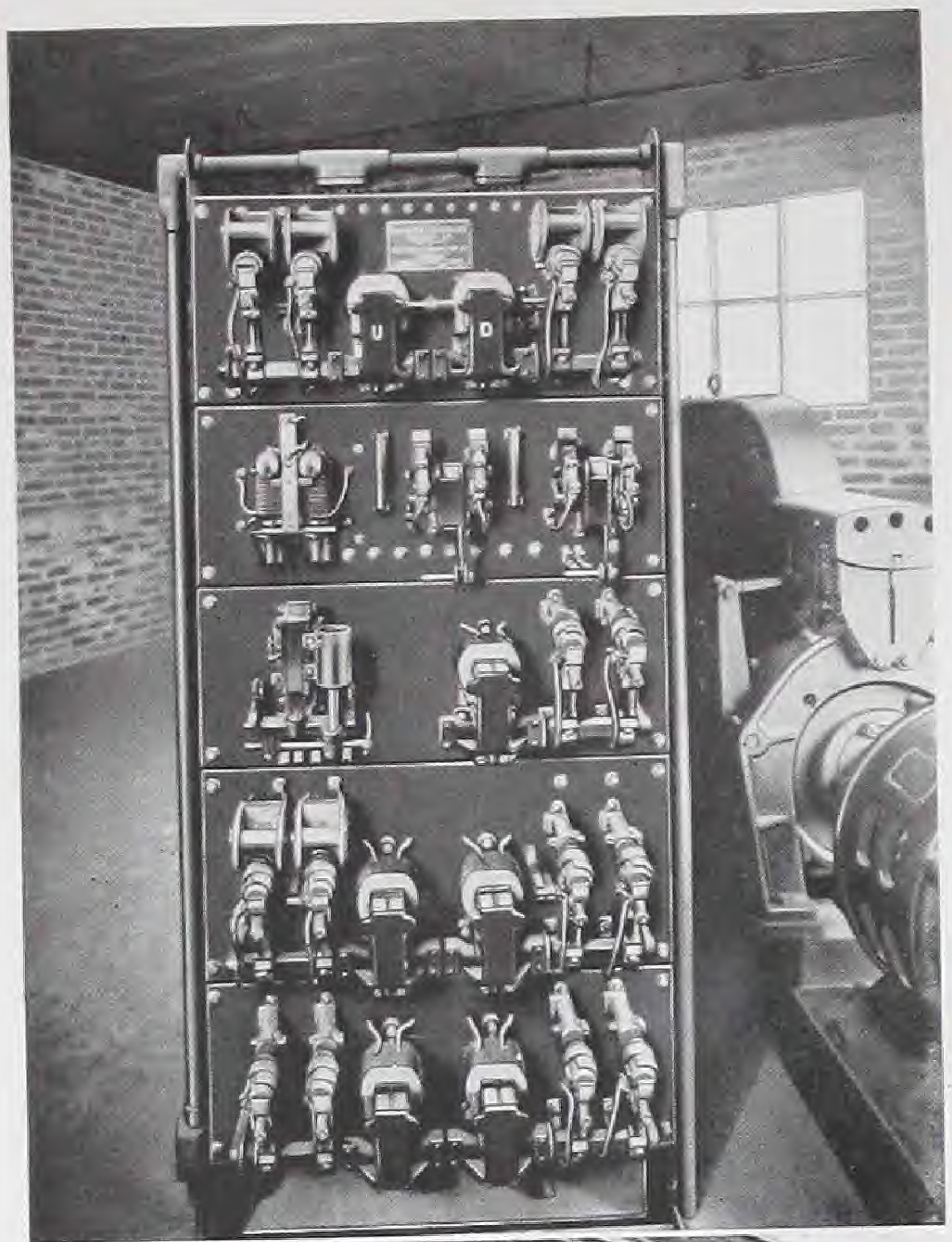
C-H Semi-Magnetic Controllers are similar in operating characteristics to the full-magnetic type insofar as the accelerating mechanism and its functions are concerned. Reversing is performed manually through a drum-type reversing switch which may either be mounted separately or combined with the starting panel as a single unit and mounted on a floor type frame. The switch is usually operated through a shipper rope running up and down the hoistway. This shipper rope may be attached to a lever or to a wheel within the car itself.

The sheave wheel for operating the reversing switch is mounted directly on the reversing shaft which projects to the rear of the switch. The center portion is notched so that the "run" and "off" positions are readily felt by the operator.

Low-voltage protection is usually provided in connection with semi-magnetic controllers because of the additional safety which its use insures. Without low-voltage protection, the car will start unexpectedly after a voltage failure if the shipper rope happens to be left in the "run" position. This protection will also prevent the car from starting upon closure of a gate or door, where door switches are used, without first moving the drum reversing switch to the "neutral" and then to the "run" position. Dynamic braking may be used in connection with semi-magnetic controllers of the direct-current type. This type of braking is recommended for heavy duty service.



Bulletin 9717 Self-Contained Semi-Magnetic Alternating-Current Elevator Controller with Phase-Failure and Low-Voltage Protection



LOS ANGELES BRANCH FACTORY
of the
GOODYEAR TIRE AND RUBBER CO.

This modern industrial plant is equipped with Cutler-Hammer elevator controllers for both passenger and freight service.

The illustrations top and bottom show two of the Bulletin 9871 single-speed alternating-current controllers which are a part of this installation.

Direct-Current Controllers

Two standard controllers—Bulletins 7301 and 7331—take care of practically all types of direct-current elevator installations. Bulletin 7301 is used in connection with single-speed motors on elevators with car speeds not greater than 175 feet per minute, or with dumb waiters which run at speeds not greater than 300 feet per minute. Bulletin 7331 is used in connection with both single and two-speed motors where the car speed does not exceed 200 feet per minute for the single-speed motor and 350 to 400 feet per minute for the two-speed equipment.

Full-Magnetic Direct-Current Controllers

BULLETIN 7301

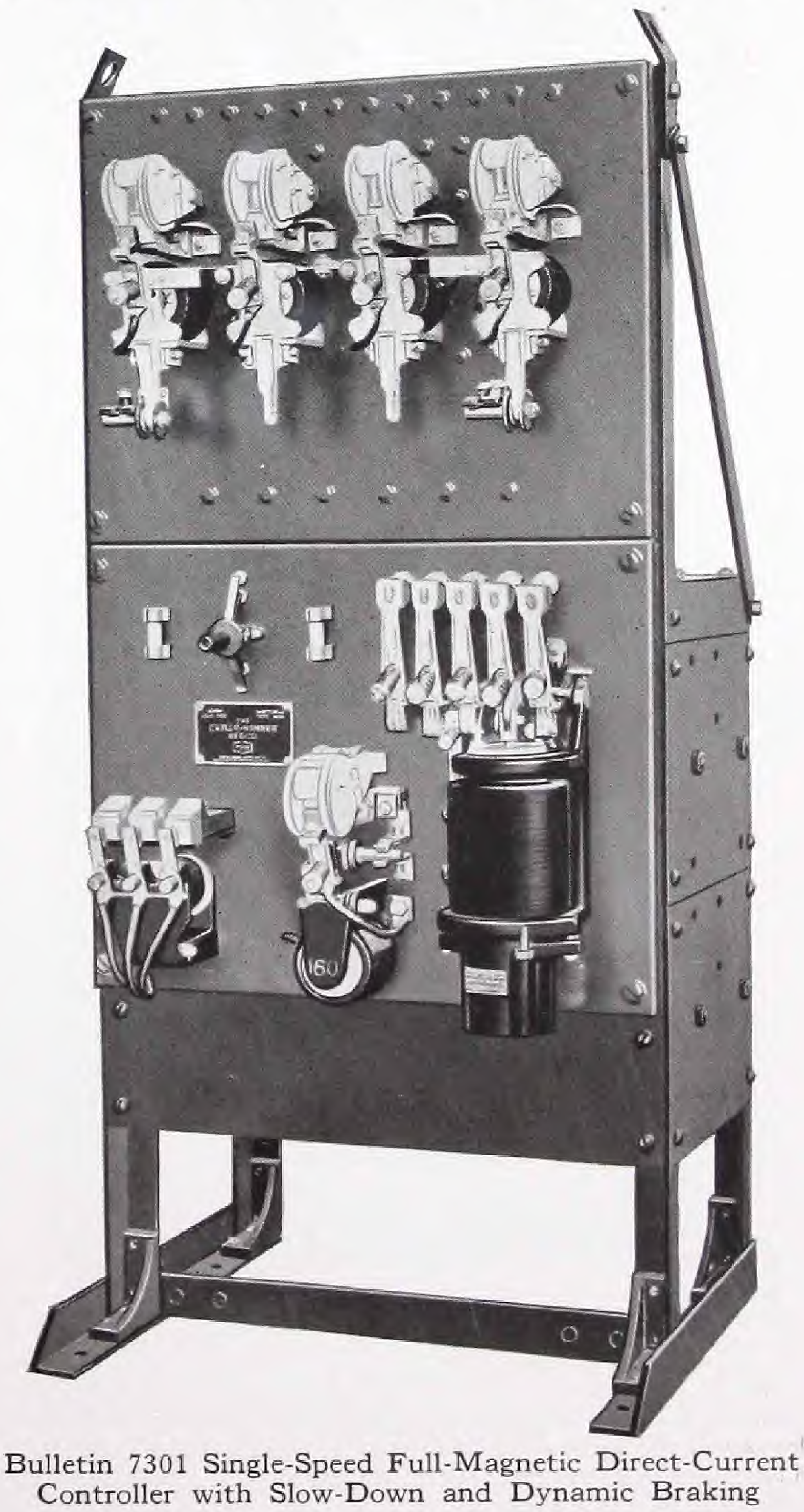
For Single-Speed Passenger or Freight Service Not Greater than 175 Feet per Minute or Dumb Waiters with Speeds Not Greater Than 300 Feet per Minute

C-H Bulletin 7301 is a ruggedly constructed controller which consists essentially of four reversing contactors, an accelerating movement, a three-prong field and brake relay, a try-out switch and control fuses. The reversing contactors are of the single-pole type with carbon-to-copper contacts. They are mechanically interlocked with a very simple mechanism, which does not interfere with their operation, but which absolutely prevents their closing in any but the proper manner. The reversing contactors are provided with powerful magnetic blowouts. As already outlined, the contacts used on all C-H Elevator Controllers are interchangeable with those of like capacity used on either direct or alternating-current service.

The accelerating movement is of the standard time-limit type already described. The contact fingers are of the butt type, very rugged and easily renewed. The oil dashpot is entirely enclosed and cannot splash or leak oil. A sufficient quantity of dashpot oil is included with every controller. When the dashpot is once set, the starter will always cut out the resistor in the same length of time. By means of a patented resistor interlock, the motor can only be reversed when all of the starting resistor is in circuit. The three-prong field and brake relay contacts are of carbon and copper, and are interchangeable with those used on the reversing contactors. The try-out switch permits the operator to test the operation of the equipment from the control panel.

When car-switch control is used and the slow-down feature is included, one five-wire and one two-wire car control cable are necessary. Without this feature, a three-wire cable may be used in place of the five-wire cable.

With push-button control a floor selector is required for elevator installations having three or more landings. Three-landing dumb waiters



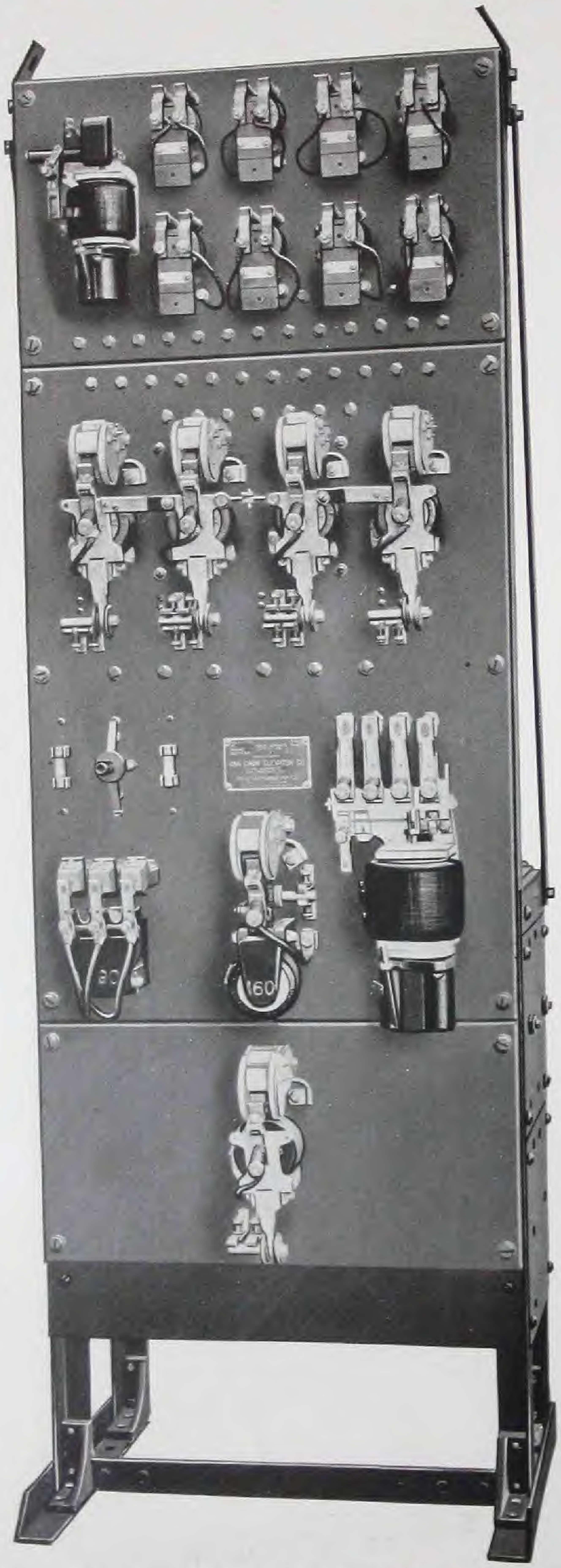
Bulletin 7301 Single-Speed Full-Magnetic Direct-Current Controller with Slow-Down and Dynamic Braking

may be arranged for satisfactory operation without the use of floor selectors provided no slow-down is desired. No floor selector is required for two-landing elevators. Two hoistway limit switches are used for the regular terminal stops and two more for emergency overtravel protection. When slow-down is desired, two more hoistway limit switches can be used. For equipments of three or more landings, only two hoistway limit switches need be used; these provide emergency overtravel protection.

When push-button control is used the car is some times "stolen" before the person in it has had a chance to open the car gate or door after arriving at his destination. To overcome this objection a non-interference relay may be used to provide ample time for opening the gate or door.

These controllers are adapted to direct push-button operation on 115 or 230-volt circuits. When only 550-volt direct-current service is available for the power circuit, a lower voltage, either alternating or direct current, must be provided for the control circuit.

When using the Bulletin 7301 controller with car speeds over 100 feet per minute the slow-down feature should be included with the controller. This speed is about 30 percent of full running speed. Whenever slow-down is supplied, dynamic braking is also included. With dynamic braking a field maintaining resistor is used. When dynamic braking is not provided, a field discharge resistor is necessary on all 550-volt controllers and on 230-volt controllers above 7½ hp. This field discharge resistor protects the apparatus against the high voltage which results when the shunt field of the motor is suddenly opened.



Bulletin 7301 Single-Speed Push-Button-Operated Direct-Current Controller Equipped with Slow-Down, Dynamic Braking, Non-Interference Relay and Main Switch. This Particular Controller is Arranged for Six Landings

Typical Installation of Bulletin 7301 Single-Speed Push-Button Operated Direct-Current Elevator Controller Equipped with Slow-Down and Dynamic Braking

BULLETIN 7331

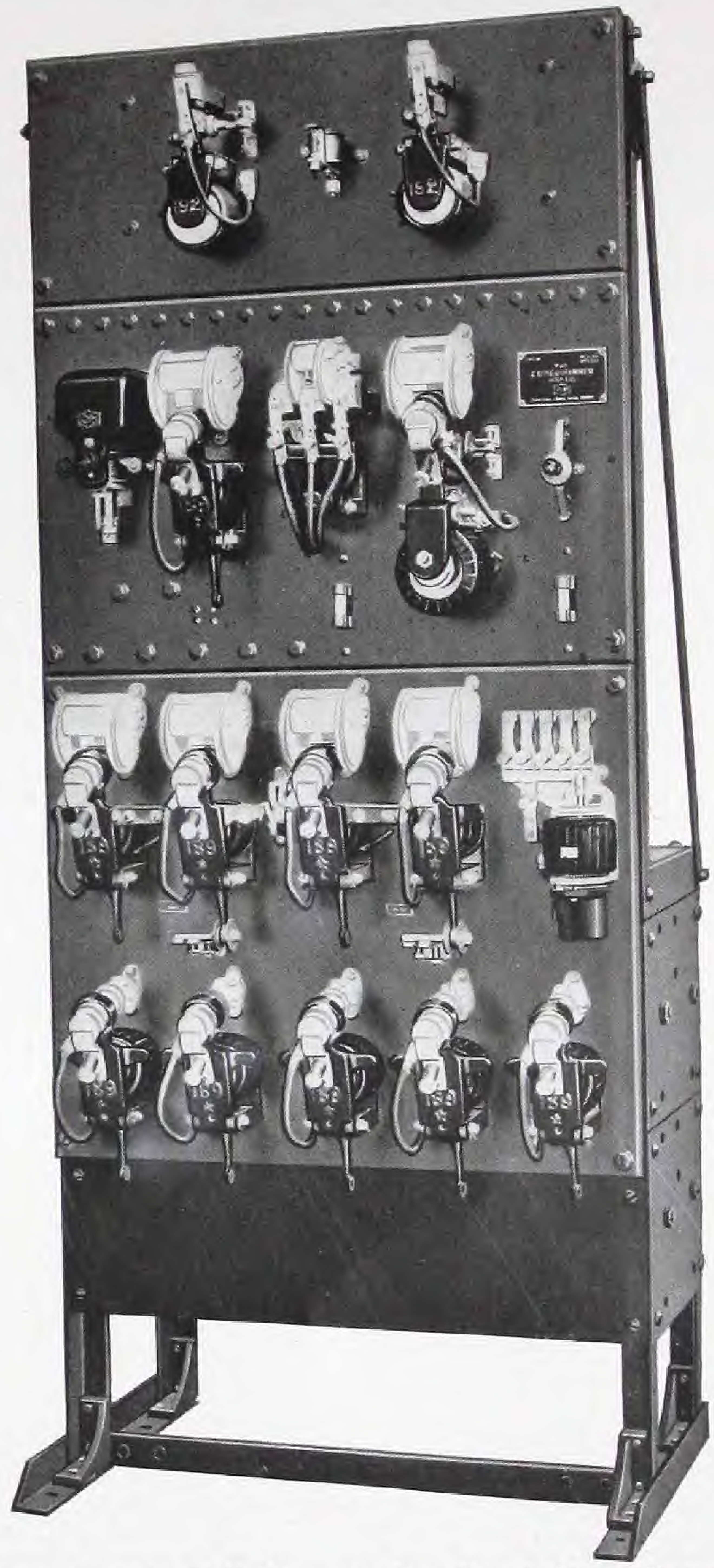
For Single and Two-Speed Passenger or Freight Service Not Greater than 400 Feet per Minute

As previously outlined the Bulletin 7331 controller may be used with both single and two-speed motors. A single-speed motor should not be used above 175 or possibly 200 feet per minute. For higher speeds, motors having a two-to-one speed range by shunt-field control should be used. The limiting car speed with this type of motor is approximately 350 to 400 feet per minute. Special controllers are required for higher speeds.

With this type of controller on single-speed equipment, the slow-down speed will be approximately 30 percent of the high speed. On two-speed equipment, the full-field speed will be one-half the maximum speed and the slow-down speed will be 30 percent of this speed. To illustrate, with a car whose maximum speed is 350 feet per minute, the full-field speed will be 175 feet per minute and the slow-down speed 50 feet per minute. On push-button equipment, the speed always changes from high to slow-down before stopping, while with car-switch control all three speeds are governed by the position of the car-switch operating handle.

For very smooth stopping of the elevator car graduated slow-down and dynamic braking are recommended. This graduation is obtained by means of a magnetic lockout contactor in the dynamic braking circuit and a full-field contactor in addition to the spring-closed dynamic braking contactor which is furnished on the standard equipment.

On the control panel of a C-H Bulletin 7331 are a main magnetic contactor, four single-pole reversing contactors, which are mechanically interlocked, five armature accelerating contactors, an accelerating relay, a spring-closed dynamic braking contactor, a three-prong brake and field relay, a double-coil overload relay, try-out switch and control fuses. On the two-speed equipment there are also two field-weakening contactors and a field relay. The main magnetic contactor is included for the purpose of securing an additional break in the motor circuit; it provides that additional measure of safety which is essential on high-speed equipment. The construction of the contactors and the accelerating mechanism is of the same sturdy type as described under Bulletin 7301. Six steps of acceleration are provided on the single-speed equipment and eight steps on the two-speed. After starting, the series field is cut out in one step. The



Bulletin 7331 Full-Magnetic Two-Speed Direct-Current Controller with Slow-Down Feature and Arranged for Car-Switch Operation

patented resistor interlock prevents reversing the motor until all the starting resistance is in the circuit. The spring-closed dynamic braking contactor establishes the slow-down and dynamic braking circuits. The three-prong brake and field relay establishes a full shunt field for starting and energizes the brake magnet coil. The double-coil overload relay provides overload protection and is automatically reset by the car switch when the handle is moved to the "neutral" position or by the push button when

the "starting" button is again depressed. The try-out switch provides for testing the equipment directly from the panel for both full-field and slow speeds.

For single-speed car-switch control, one six-wire and one two-wire car-control cable are necessary. For two-speed motors one seven-wire and one two-wire car-control cable must be used.

With push-button control, it is usually desirable to use a two-speed motor for lower car speeds than would be necessary for car-switch operation in order to get more accurate stops.

As outlined under Bulletin 7301, a floor selector must be used for equipment having three or more landings. For two-landing equipments, two hoistway limit switches for slow-down control, two for terminal stops and two for emergency overtravel protection are provided for the usual installation. For drum type elevators a rotating-cam machine-limit device, Bulletin 10310, or a traveling-cam machine-limit device, Bulletin 10312, can be used in place of the slow-down and terminal stop limits. Hoistway limit switches should be used for emergency overtravel protection for all installations no matter how many landings there may be.

A non-interference relay is usually desirable to provide ample time for the opening of the gate or door; otherwise the elevator car may be "stolen" before the person in the car has had an opportunity to open the car gate or door after arriving at his destination.

Semi-Magnetic Direct-Current Controllers

BULLETIN 7021

With Time-Limit Acceleration for Moderate-Duty Slow-Speed Freight Service

When dynamic braking is used with the Bulletin 7021 controller to assist the mechanical brake in stopping the elevator, a field maintaining resistor is provided and no field discharge resistor is necessary. Without dynamic braking, a shunt-field discharge resistor is provided on all 550-volt controllers and on 230-volt controllers of 7½ hp. and above. This field discharge resistor protects the apparatus against the high voltage which results in the shunt field of the motor when it is suddenly opened. No field discharge resistor is necessary on the smaller sizes.

On the control panel of this equipment is a main magnetic contactor and an automatic starter. The reversing switch is of the drum type and is mounted separately.

Acceleration of the motor is controlled by a standard oil-filled dashpot, which can be easily adjusted to suit operating conditions. When once set, the dashpot causes the starter to cut out the resistor in the same length of time. After starting, the series field of the motor is cut out in one step. Because of the patented interlock, the motor cannot be reversed until the starting resistor is in circuit.

Standard C-H elevator construction is used throughout. Contacts are of carbon and copper and a powerful magnetic blowout is provided. The reversing switch is very rugged. Both the segments and the contact fingers are mounted on standard insulated square steel shafts. The finger supports are so arranged that metallic dust cannot cause short circuits or partial grounds. The terminals are mounted at the top of the switch where they are easily accessible.

When Bulletin 7021 is used with a winding drum type elevator, the traveling nut on the elevator machine should be arranged to throw the drum reversing switch to the "off" position at the normal limits of travel. With traction type elevator machines, suitable hoistway limit switches may be used for obtaining the terminal stops.

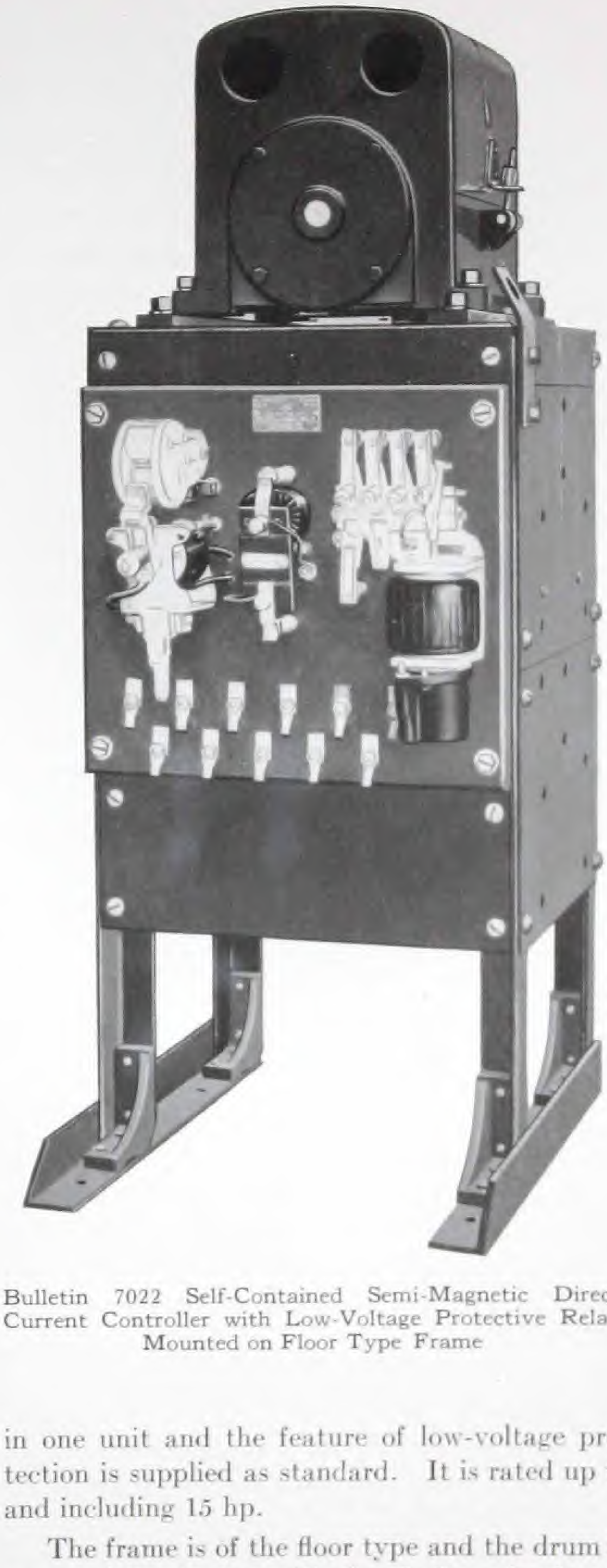
Bulletin 7021 Semi-Magnetic Direct-Current Controller Arranged for Use with Drum Type Reversing Switch on Moderate-Duty Freight Elevator Service

All semi-magnetic controllers are arranged for the operation of a magnetic brake. When such a brake is installed, hoistway limit switches similar to Bulletin 10315 can be used in place of the more expensive traveling-nut device. In any case, all installations should include two hoistway limit switches in addition to the normal stop limits in order to prevent dangerous over-travel.

BULLETIN 7022

Combined Unit with Contactor Panel and Reversing Switch on Floor Type Frame

This controller is practically the same as Bulletin 7021, except that the drum reverse switch and magnetic panel are mounted together



Bulletin 7022 Self-Contained Semi-Magnetic Direct-Current Controller with Low-Voltage Protective Relay, Mounted on Floor Type Frame

Rear View of Bulletin 7022 Self-Contained Traction Type Semi-Magnetic Controller, Showing Sheave Wheel

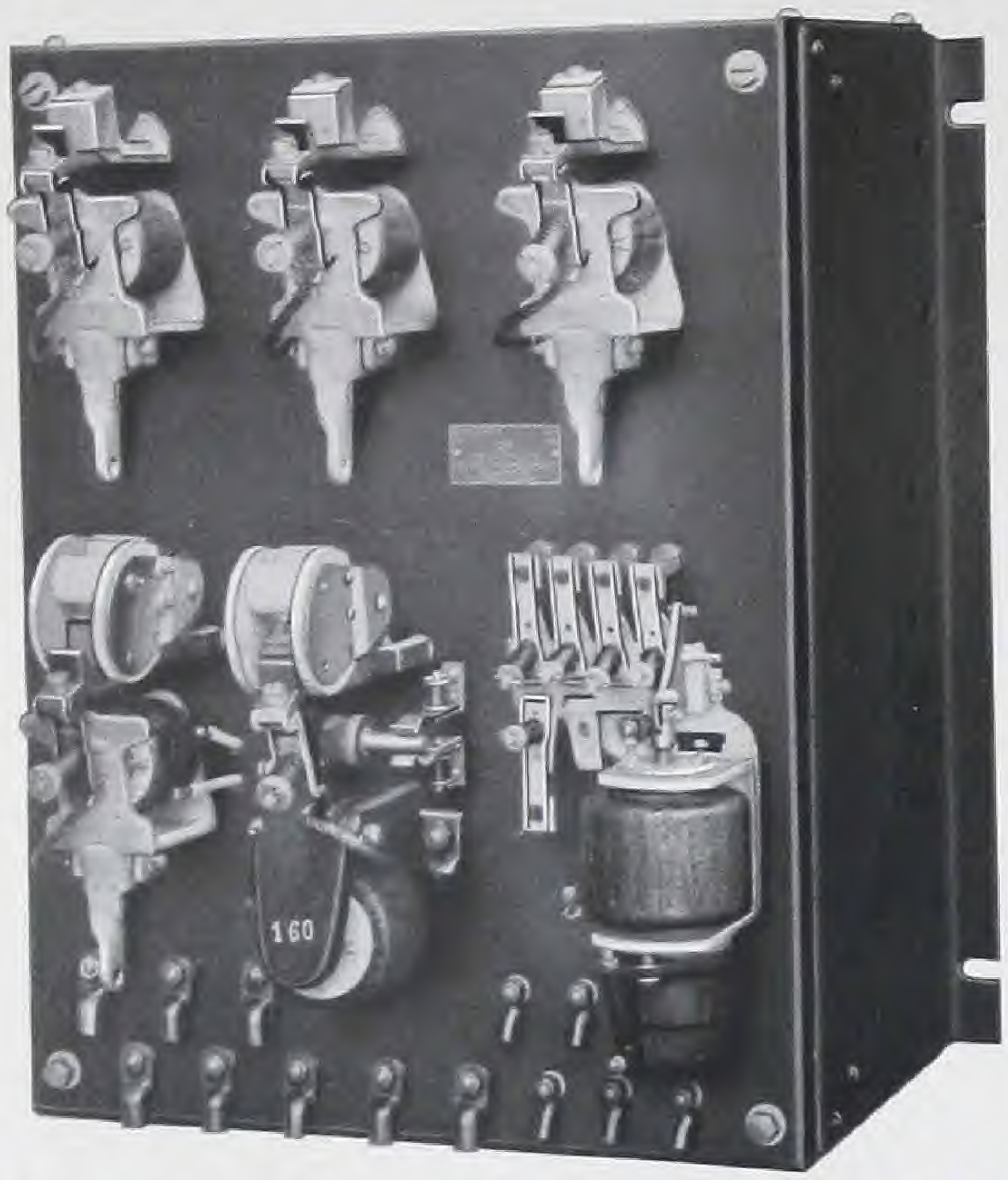
in one unit and the feature of low-voltage protection is supplied as standard. It is rated up to and including 15 hp.

The frame is of the floor type and the drum is mounted on the top with the shaft projecting to the rear for convenient mounting of the sheave wheel. Extension to the rear of the frame provides stops for the sheave wheel by means of an extending lug which must be a part of the sheave. The type "M" drum is always furnished, as the smaller drum is not strong enough to carry the sheave wheel without an outboard bearing, a very undesirable feature. This controller can be furnished with or without the sheave wheel.

BULLETIN 7041

With Time-Limit Acceleration for Heavy-Duty Slow-Speed Freight Service

When dynamic braking is used in connection with this controller it is suitable for elevators with speeds as high as 150 feet per minute. Without the dynamic braking feature, however, this controller



Bulletin 7041 Semi-Magnetic Direct-Current Controller Arranged for Use with Drum Type Reversing Switch on Heavy-Duty Freight-Elevator Service

is not recommended for use with car speeds over 100 feet per minute.

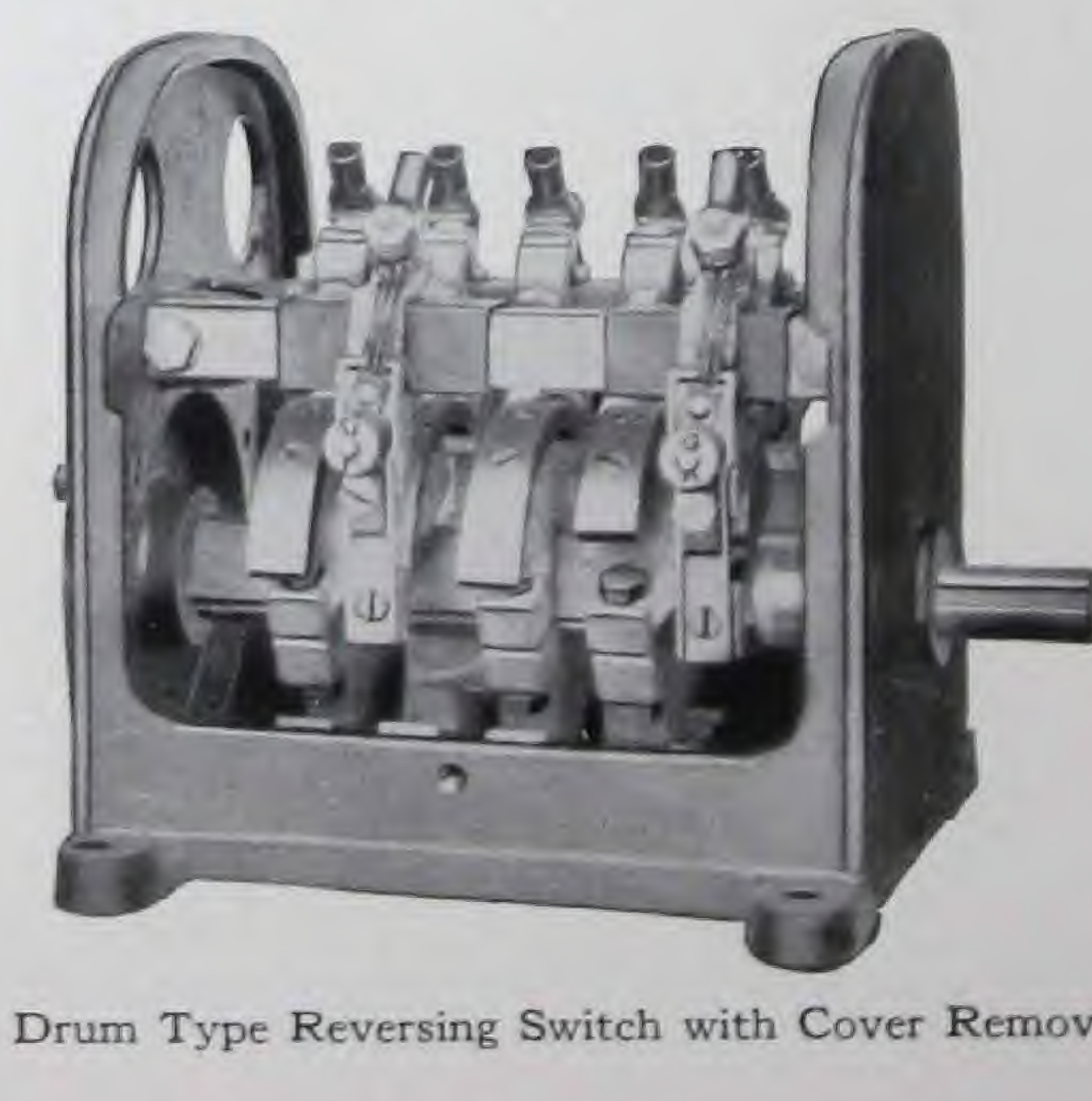
As in the case of the Bulletin 7021 controller, a field maintaining resistor is used when dynamic braking is provided; otherwise a field discharge resistor is necessary on all 550-volt controllers and on 230-volt controllers of 7½ hp. and above. This field discharge resistor protects the apparatus against the high voltage which results when the shunt field circuit is suddenly opened. No field discharge resistor is necessary for the smaller sizes.

C-H Bulletin 7041 consists of two units. The starting panel contains a main magnetic contactor and an automatic starter of the standard type. The reversing switch is of the standard drum type described under Bulletin 7021. Square steel shafts, suitably insulated, support the fingers and segments. The fingers and segments are of standard design, very rugged and easily renewed. No wood is used in the construction. The design is such that metallic dust cannot cause short-circuits or partial grounds. The terminals are mounted on the top of the switch and are very accessible.

The main magnetic contactor and the accelerating mechanism is of the standard rugged C-H design already described. A powerful magnetic blowout is used on the main contactor. Connections are so made that the arcing is handled by this contactor, thus relieving the reversing switch of this duty. All contacts are interchangeable with each other and with those of like capacity for alternating-current service. The accelerating contactors are operated by means of a standard time-limit relay. The dashpot is entirely enclosed, so that leakage or splashing of oil is impossible. Adjustment of the time of acceleration is readily made, and, when once made, is permanent.

When a C-H Bulletin 7041 is used with a winding drum type elevator, a traveling nut on the elevator machine should be arranged to throw the drum reversing switch to the "off" position at the normal limits of travel. With traction type elevator machines, hoistway limit switches may be used for obtaining the terminal stops, and buttons on the shipper rope can be used to center the drum reversing switch.

All semi-magnetic elevator controllers are arranged for the operation of a magnetic brake. When such a brake is installed, hoistway limit switches similar to Bulletin 10315 can be used in place of the more expensive traveling-nut devices. In any case, all installations should include two hoistway limit switches, in addition to the regular terminal stop limits to prevent dangerous overtravel of the elevator.



Drum Type Reversing Switch with Cover Removed

Alternating-Current Controllers

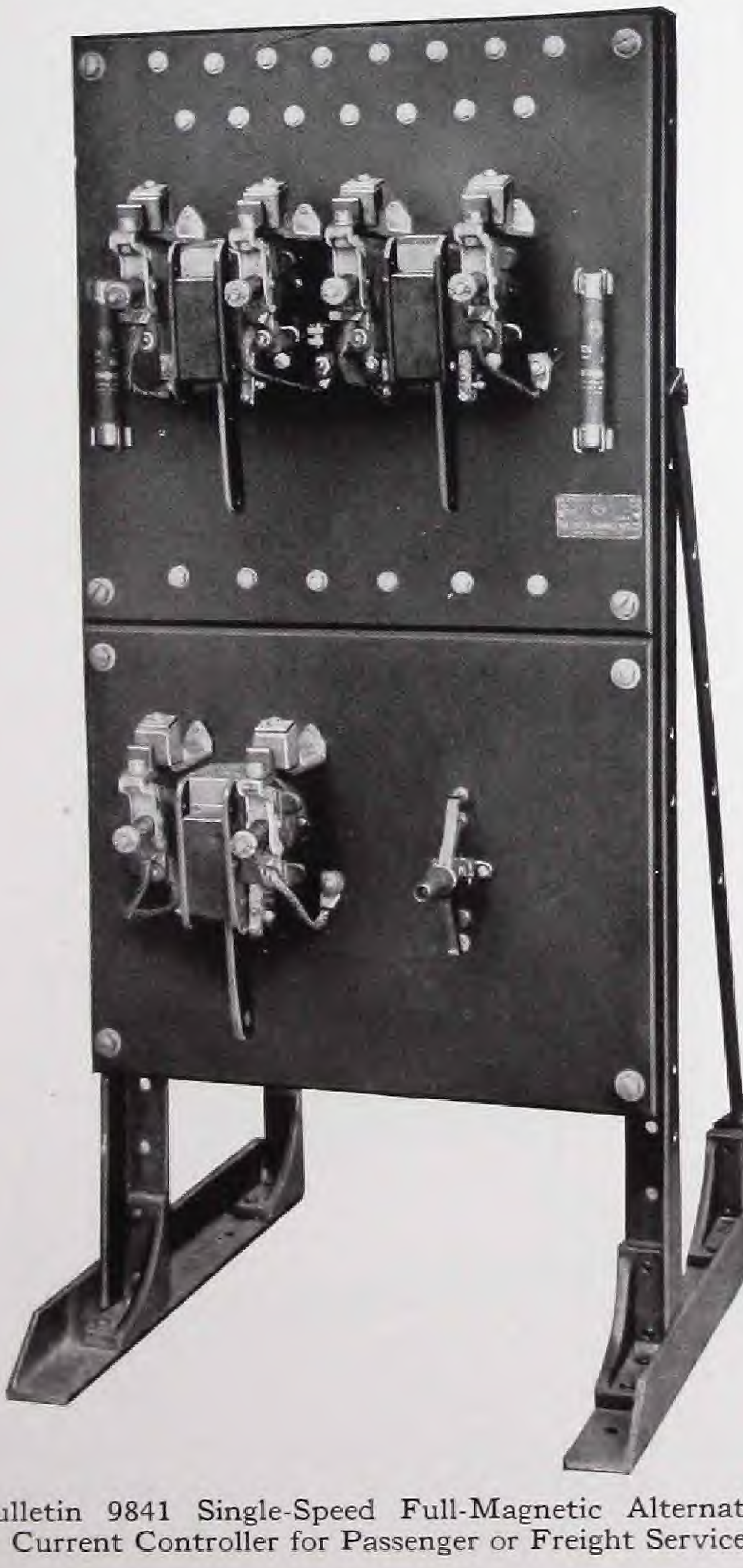
Two controllers, Bulletins 9841 and 9871, provide the features which are necessary for elevators with speeds up to about 200 feet per minute. Two other controllers, Bulletins 9843 and 9872, are used with two-speed motors to obtain higher car speeds.

Full-Magnetic Alternating-Current Controllers

BULLETIN 9841

For Single-Speed Passenger or Freight Service Not Greater Than 125 Feet Per Minute or Dumb Waiters with Speeds Not Greater Than 150 Feet Per Minute

The Bulletin 9841 controller is for use with single-speed high-torque squirrel-cage motors whose inrush current is not over three times the normal full-load current when thrown directly across the line. This controller is not recommended for car speeds in excess of 125 feet per minute for either car-switch or push-button control. For dumb waiters the speed may safely reach 150 feet per minute. The use of an automatic primary resistor will provide smooth acceleration.



Bulletin 9841 Single-Speed Full-Magnetic Alternating-Current Controller for Passenger or Freight Service

When used for freight and passenger elevators this controller is supplied with a double-pole magnetic main contactor. For dumb-waiter service the magnetic main contactor is omitted except on two-phase four-wire circuits. In addition to the magnetic main contactor the standard control panel contains reversing contactors of the standard double-pole type, a try-out switch, and control circuit fuses. All contacts are of the standard carbon-to-copper type, interchangeable with those of like capacity on elevator type contactors for direct-current service. The reversing contactors are mechanically interlocked.

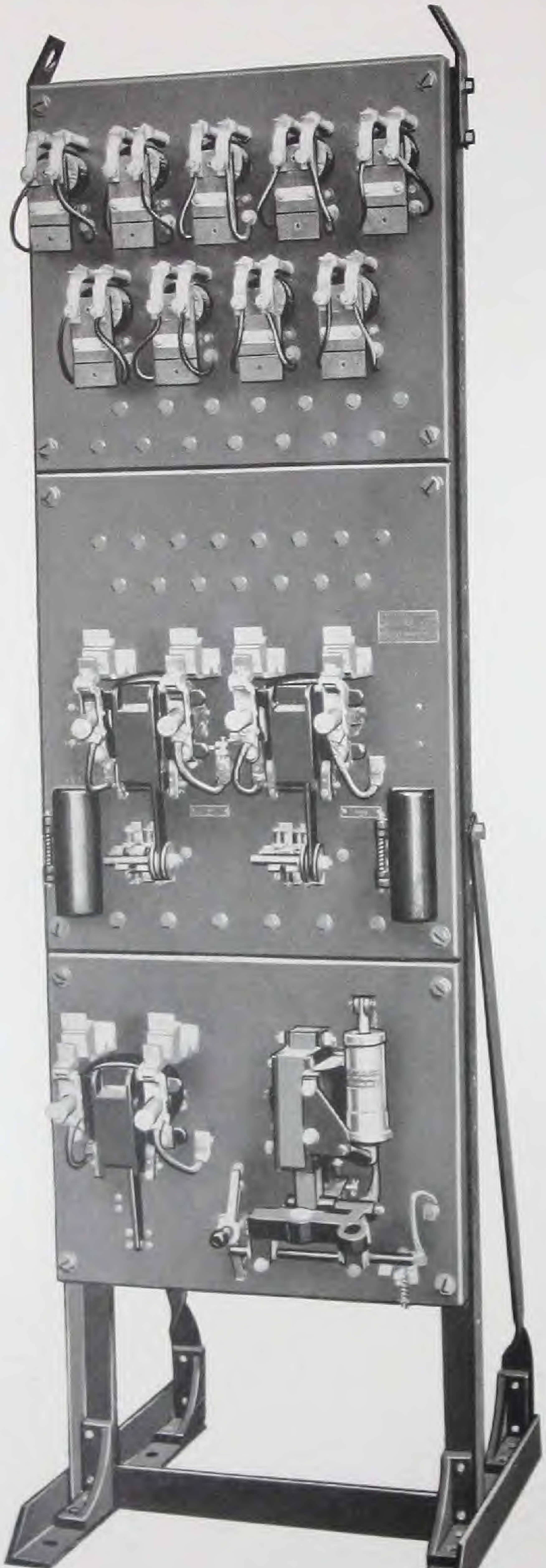
All installations in which Bulletin 9841 Elevator Controllers are used should include at least two hoistway limit switches suitably arranged to give emergency overtravel protection.

For car-switch control, one five-wire and one two-wire control cable are necessary. Overload protection for car-switch control can be provided on the control panel by adding a duplex inverse-time-limit overload relay and a magnetic interlocking relay. This arrangement provides an interlock between the overload relay and the car switch. It is necessary merely to return the car switch to the "off" position in order to reset the overload relay after an overload has occurred. The interlocking relay also provides low-voltage protection and sequence operation.

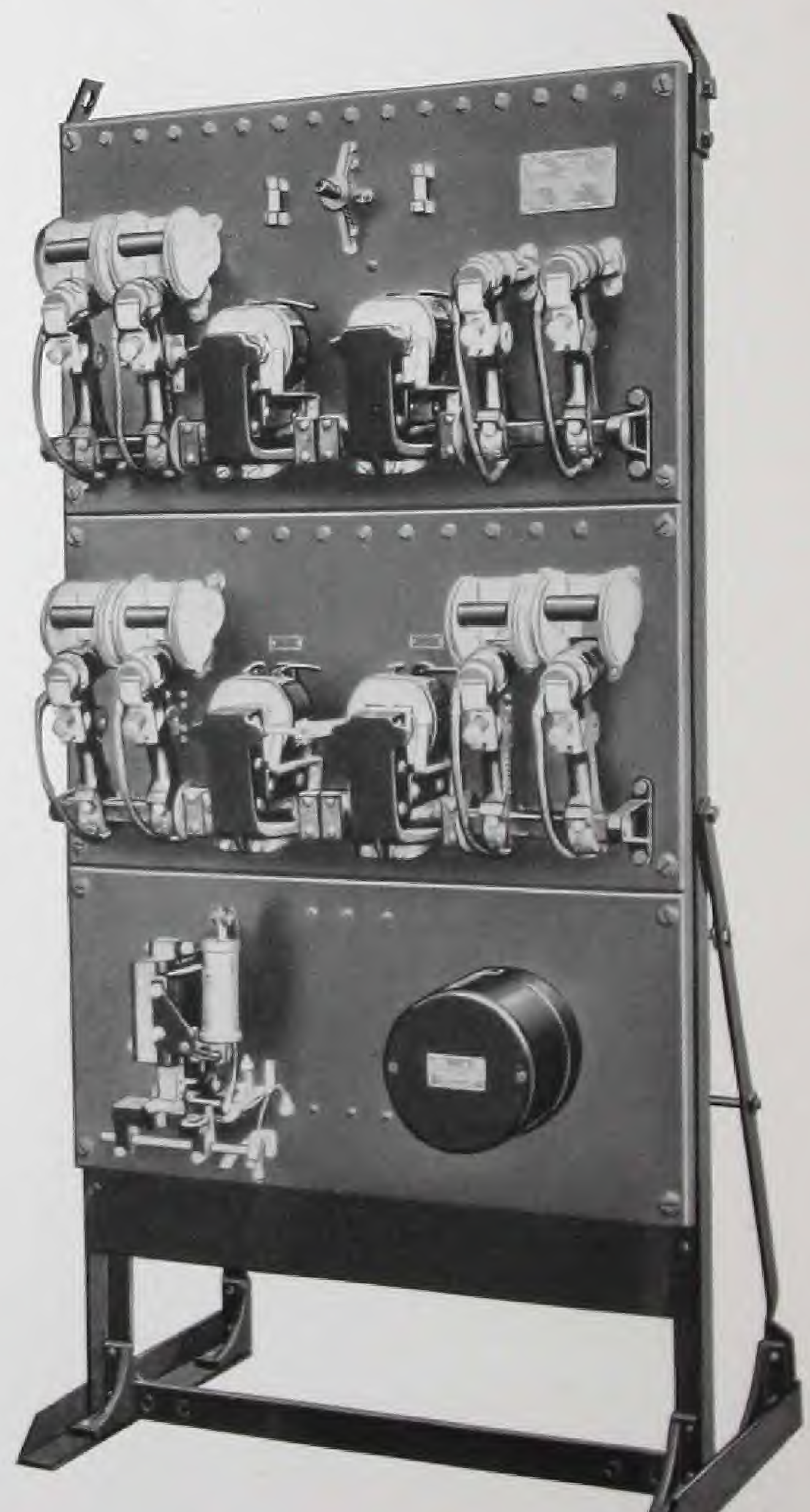
For two-landing push-button control, two additional hoistway limit switches should be used to provide for terminal stops. For more than two landings a Bulletin 10331 floor selector should be used. For dumb-waiter service no floor

selector is necessary. A relay, however, is required for the middle landing control, and five hatchway limit switches are also required, one for the middle landing stop, two for terminal stops, and two for emergency overtravel protection. Over-load protection for push-button control is provided by an inverse-time-limit overload relay. No interlocking relay is necessary. After an overload occurs and shuts down the elevator, the car may be started again simply by pressing a floor button. A non-interference relay is an optional feature of this controller. Its use prevents the car from being "stolen" before the person in the car has had an opportunity to open the car gate or door after arriving at destination.

These controllers are adapted for push-button control 110 or 220-volt circuits. For 440 or 550-volt circuits a separate low-voltage control circuit must be provided. This is obtained through the use of a two-coil step-down transformer.



Bulletin 9841 Full-Magnetic Push-Button-Operated Alternating-Current Elevator Controller with Non-Interference Relay



Bulletin 9841 Full-Magnetic Car-Switch-Operated Alternating-Current Controller with Primary Resistor and Phase-Failure and Reverse Relay

BULLETIN 9843

For Two-Speed Passenger or Freight Service Not Greater Than 300 Feet Per Minute—Used with Two-Speed High-Torque Squirrel-Cage Induction Motors

This full-magnetic controller is for use with two-speed, high-torque, squirrel-cage induction motors having two separate windings, and with equipment where a speed range not greater than six to one is desired.

The controller is normally designed for acceleration on the high-speed winding. The slow-speed winding may be used in slowing down when making a landing (and in the dynamic-braking position on push-button control, and on car-switch control if the speed governor is used).

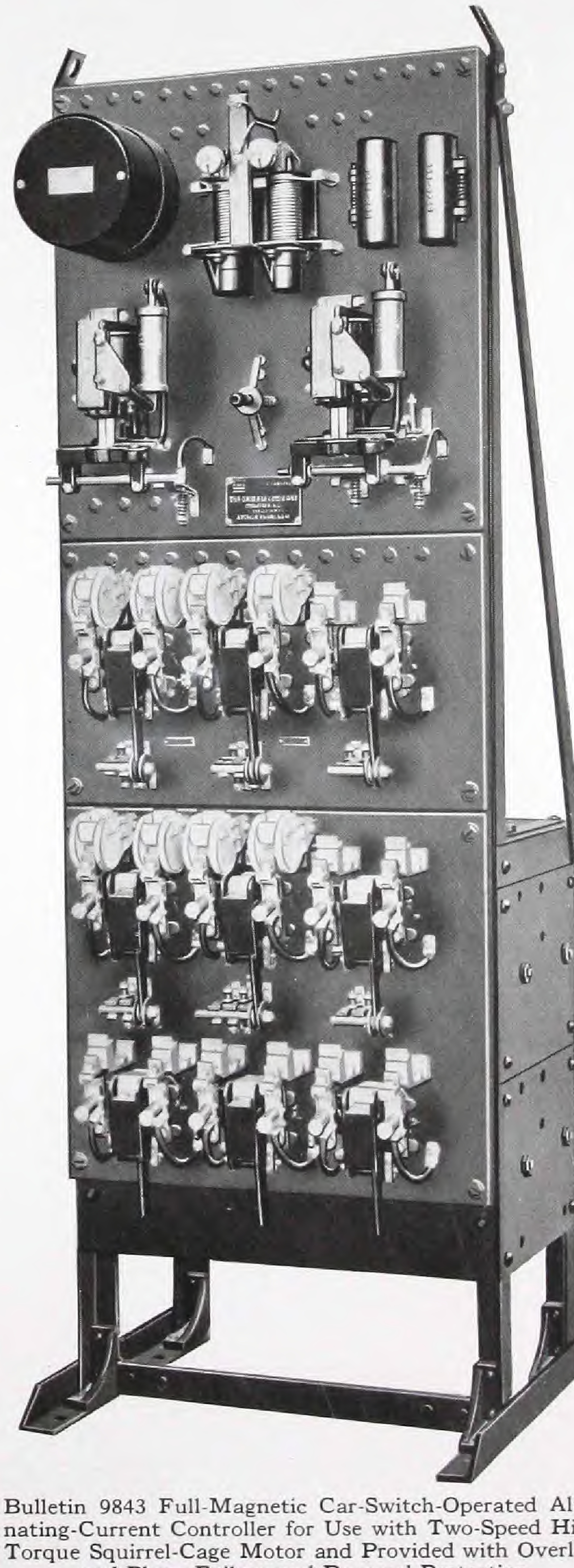
The control panel contains two reversing contactors, mechanically interlocked, and a slow and fast-speed contactor. One resistor contactor is used for the slow-speed primary, and two resistor contactors for the high-speed primary. Two gravity dash accelerating relays are used, one for the slow-speed acceleration and one for the high-speed primary acceleration. A slow-down relay, try-out switch and control fuses are also supplied.

With car-switch control one five-wire and one two-wire car control cables are necessary. A duplex inverse-time-limit overload relay and a magnetic interlocking relay are necessary to provide overload protection. The overload relay is reset by returning the car switch to the "off" position. The interlocking relay also provides overload protection and sequence operation.

With two-landing push-button equipment two additional hoistway limit switches are used for terminal stops. For more than two landings a Bulletin 10331 floor selector should be used. Overload protection is provided by adding to the panel a duplex inverse-time-limit overload relay. No interlocking relay is necessary. After an overload occurs, the car may be started again by pressing one of the floor buttons. A non-interference relay may be added to prevent the car from being "stolen" before the person in it has had a chance to open the car gate or door after arriving at destination.

Dynamic Braking Governor

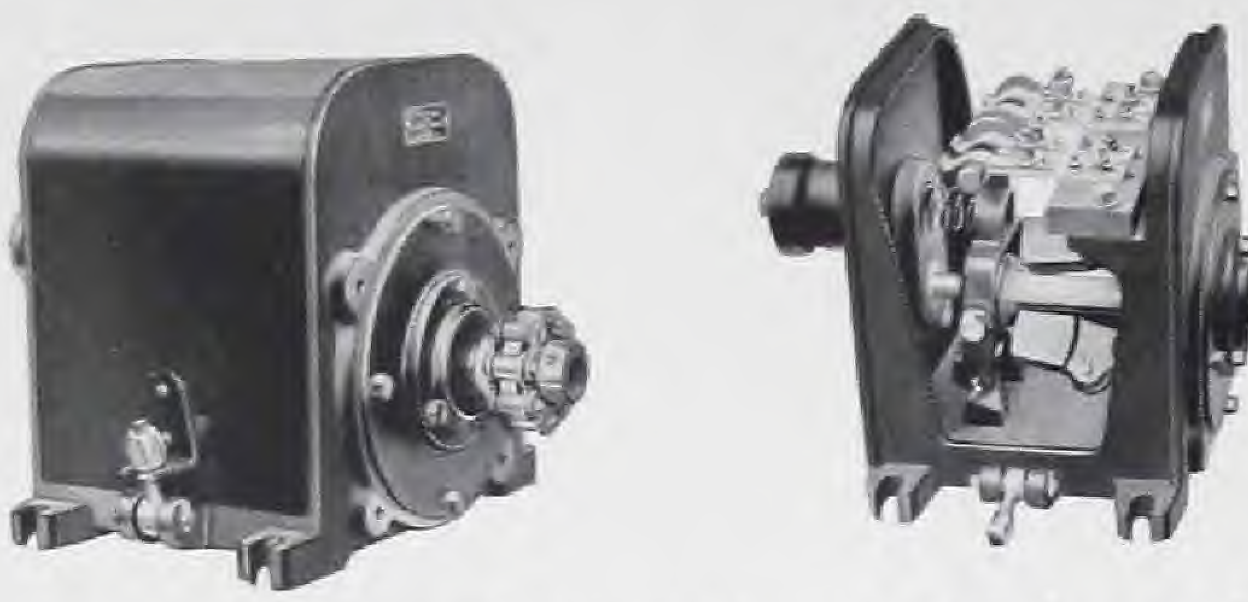
This governor operates to maintain the slow-speed winding circuit and the mechanical brake released in case the operator drops back from high speed to neutral without going through the slow-speed position. However, just as soon as the braking (due to the slow-speed winding rotating above synchronous speed) is completed, the governor opens the circuit and applies the mechanical brake. The governor as thus used eliminates the danger of extreme slide that might occur in



Bulletin 9843 Full-Magnetic Car-Switch-Operated Alternating-Current Controller for Use with Two-Speed High-Torque Squirrel-Cage Motor and Provided with Overload and Phase-Failure and Reversal Protection

dropping back from high speed to neutral with only the mechanical brake to stop the car.

The slow-down is always smooth and gradual because, when dropping back from high speed to slow speed, the high-speed circuit is maintained until the slow-speed winding is connected to the line, and also because the primary resistor is always re-inserted in the circuit before current is admitted to the slow-speed winding. The torque and dynamic braking effect are then gradually increased by again cutting out this resistor.



Dynamic-Braking Governor Shown Complete and with Cover Removed

The operating shaft of the governor is attached to a flexible coupling which allows for slight misalignment and prevents damage due to motor end-play. The operating shaft is provided with a flange which may be secured to the motor shaft by means of two round-head machine screws. No pinning or keying is necessary. The governor is noiseless in operation.

BULLETIN 9871

For Single-Speed Passenger or Freight Service Not Greater Than 200 Feet Per Minute—Used with Single-Speed Slip-Ring Induction Motors

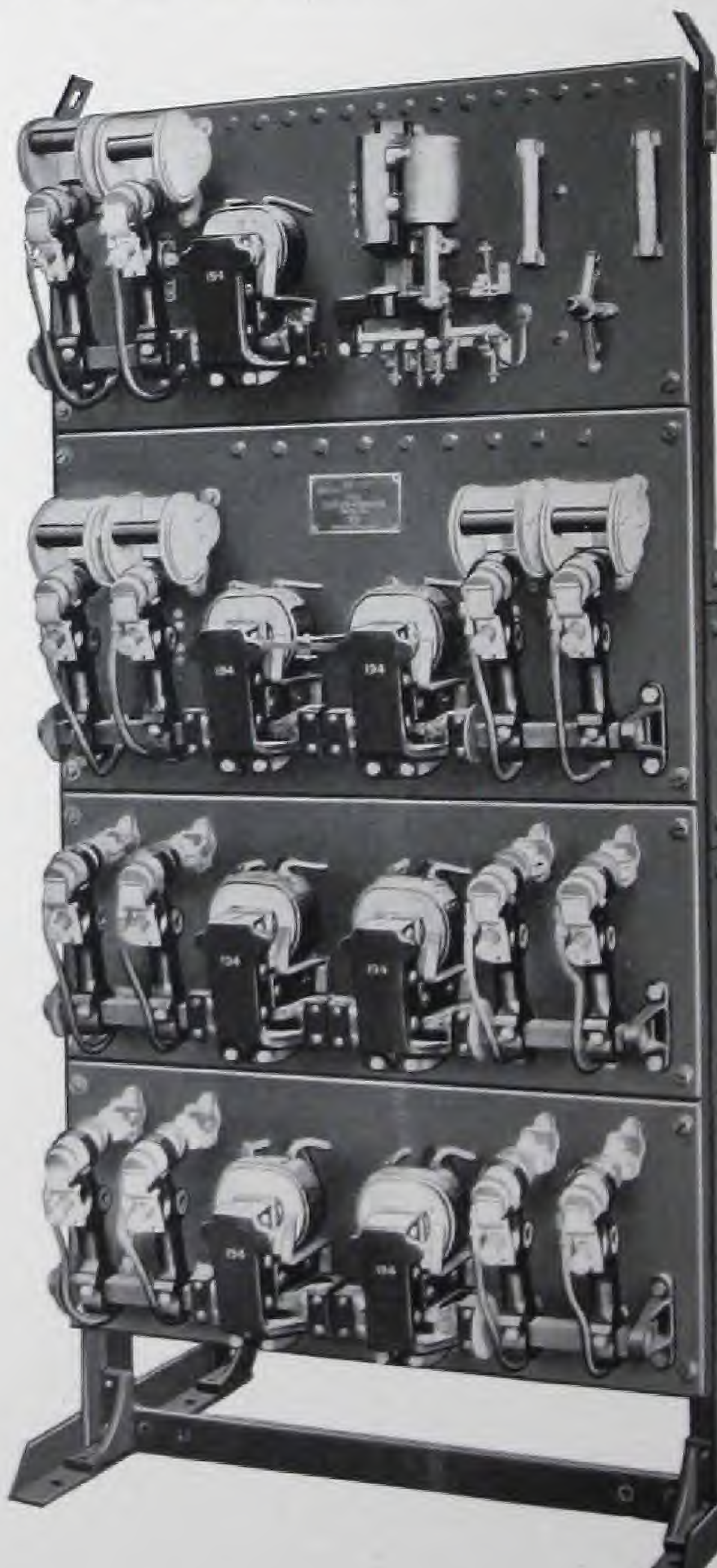
This full-magnetic elevator controller is used with single-speed slip-ring induction motors and is suitable for car speeds up to 200 feet per minute with car-switch control or 125 feet per minute with push-button control.

A double-pole main magnetic contactor, two double-pole reversing contactors with magnetic blowouts, several accelerating contactors, an accelerating relay, a try-out switch, and control fuses constitute the equipment on the control panel. In accelerating the motor, the resistor is cut out of each phase simultaneously so that the rotor currents are balanced during the entire starting period.

All installations using a Bulletin 9871 elevator controller should include at least two hoistway limit switches suitably arranged to give emergency overtravel protection.

With car-switch control, one five-wire and one two-wire car control cable are necessary. A duplex inverse-time-limit overload relay and a magnetic interlocking relay are necessary to provide overload protection. The overload relay is reset by returning the car switch to the "off" position. The interlocking relay also provides for low-voltage protection and for sequence operation.

With two-landing push-button equipment two additional hoistway limit switches are used for terminal stops. For more than two landings a Bulletin 10331 floor selector should be used. Overload protection is provided by adding to the panel a duplex inverse-time-limit overload relay. No interlocking relay is necessary.



Bulletin 9871 Single-Speed Full-Magnetic Type B Standard Controller

BULLETIN 9872

For Two-Speed Passenger or Freight Service Not Greater Than 300 Feet Per Minute—Used with Two-Speed Slip-Ring Induction Motors

This full-magnetic elevator controller is designed for use with two-speed slip-ring, induction motors having separate slow and high-speed windings. The slow-speed winding may be either of the slip-ring or squirrel-cage type, but the high-speed winding must be of the slip-ring type in all cases. This controller is suitable for use with equipment having a motor-speed range not greater than six to one, and a car speed not greater than 300 feet per minute.

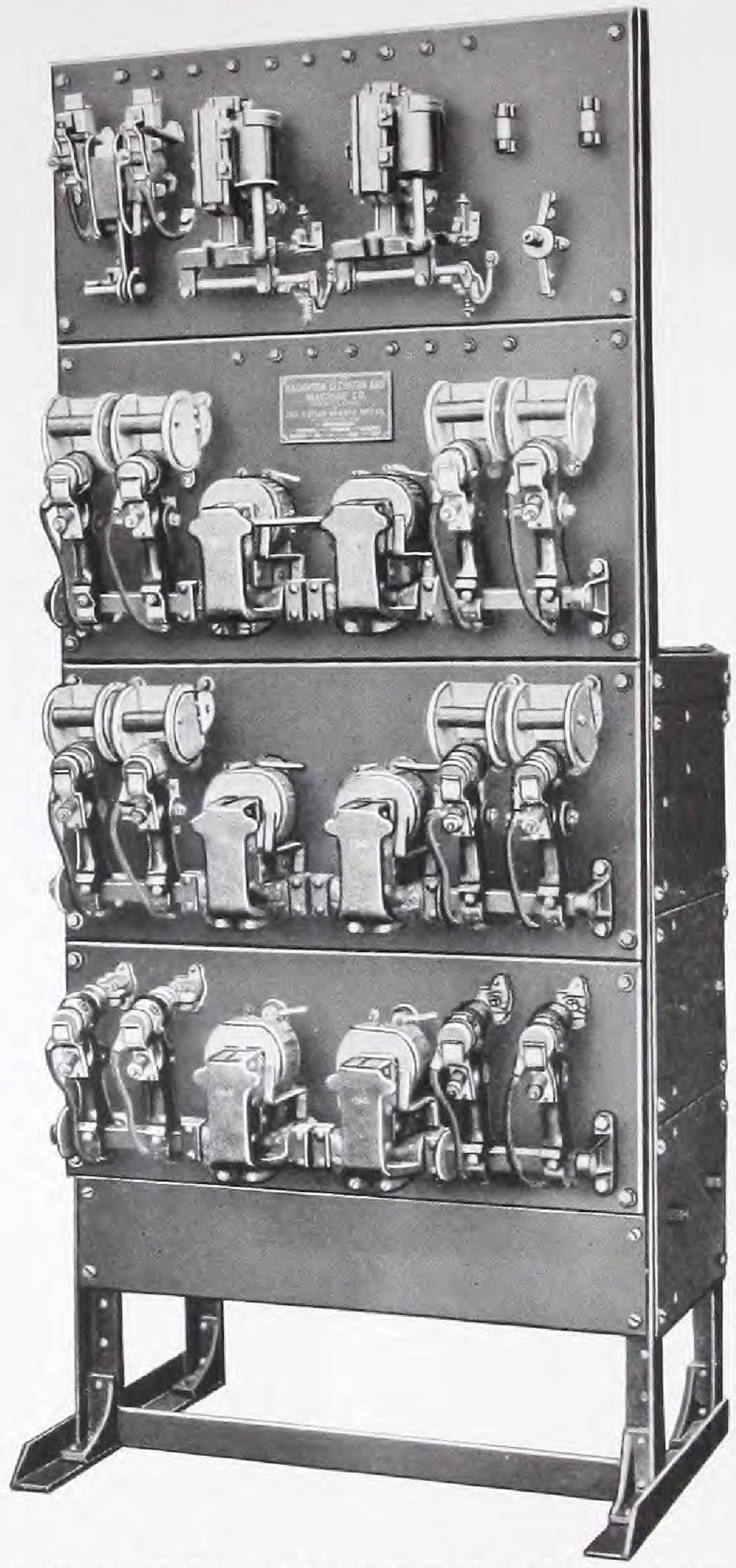
A secondary resistor is used in connection with both the high and slow-speed windings. The controller is normally designed for acceleration on the high-speed winding. Where the slow-speed winding is of the slip-ring type it is handled in the same manner as the high-speed winding, but where the slow-speed winding is of the squirrel-cage type, a step of primary resistor is connected permanently in series with each phase and one accelerating contactor is used.

With motors having both windings of the slip-ring type, the controller is normally designed for acceleration on the high-speed winding. When the operator throws the car switch to the full-speed running position in either direction, acceleration is automatic on the high-speed winding, the slow-speed winding not being used. However, the slow-speed winding is used in slowing down when making a landing (and in the dynamic braking position on push-button control, and on car-switch control if the speed governor is used). Where inching is required in order to make a more accurate stop, the slow-speed winding may also be used, dependent upon the way the operator manipulates the car switch. For instance, if he moves the car switch to the first position only, the slow-speed winding will operate the motor at slow speed.

Acceleration from rest on the high-speed winding is remarkably smooth. After inching, the operator can go from slow to high speed without dropping back to neutral.

The control panel contains two reversing contactors, mechanically interlocked, and a slow and fast-speed contactor. Four accelerating contactors are used and controlled by gravity accelerating relays. A slow-down relay, try-out switch and control fuses are also supplied.

Low-voltage release on car-switch control and low-voltage protection on push-button control are inherent features. Automatic restarting of the elevator upon return of voltage after failure is thus prevented unless the car switch is again moved to the running position or one of the push buttons is operated.



Bulletin 9872 Two-Speed Full-Magnetic Controller

A speed governor which will give automatic dynamic braking may be supplied. The operation is similar to that explained in the Bulletin 9843.

On push-button control, overload protection and the non-interference relay features are optional at additional cost. Optional features for car-switch control include overload protection and the speed governor previously mentioned.

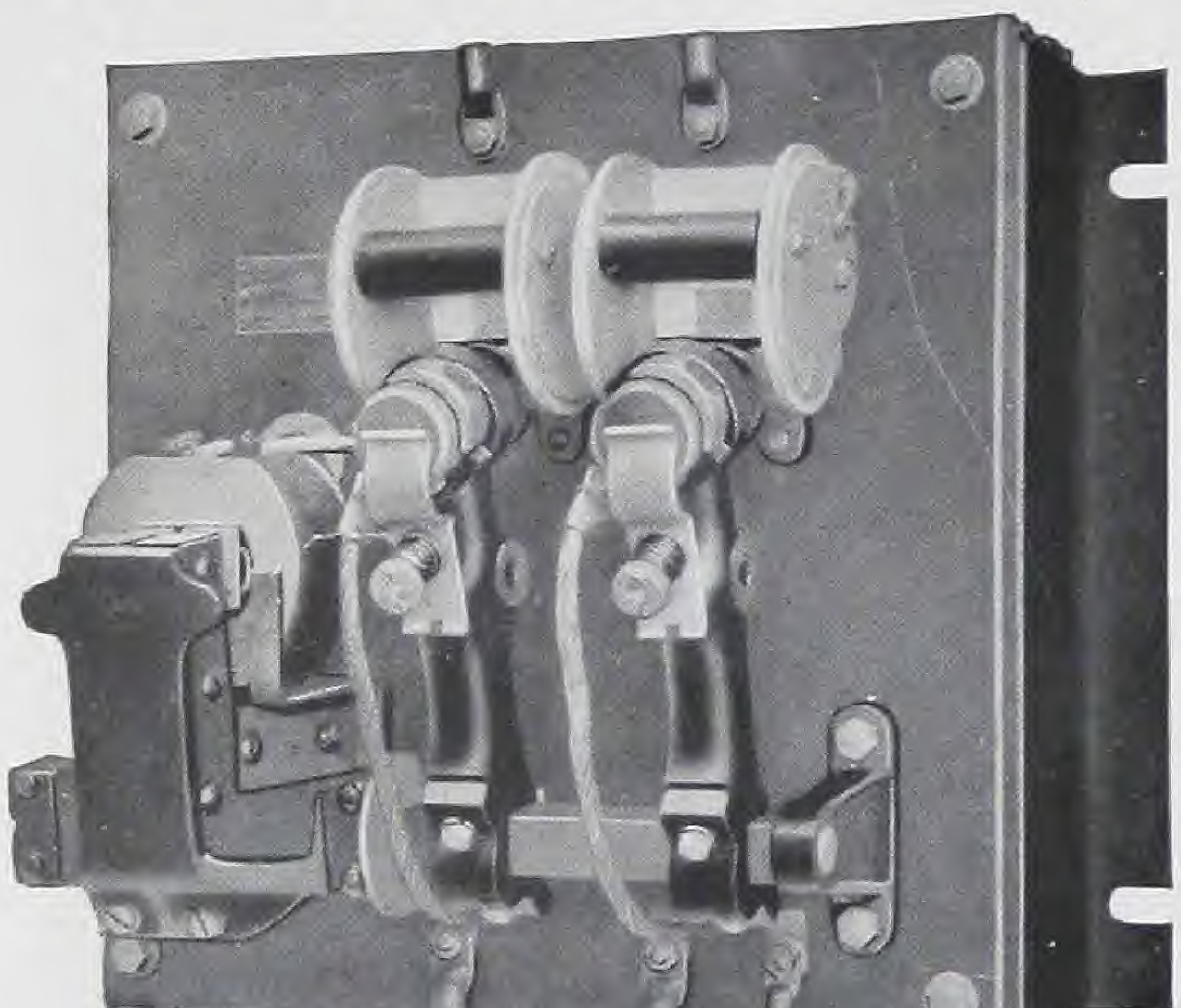
Semi-Magnetic Alternating-Current Controllers

C-H Bulletins 9716, 9717 and 9776 are semi-magnetic controllers used for slow-speed elevators. Bulletins 9716 and 9717 are designed for handling high-torque squirrel-cage motors which can be directly connected to the line. Bulletin 9776 is used with single-speed slip-ring motors on installations whose car speeds do not exceed 150 feet per minute.

BULLETIN 9716

For Slow-Speed Elevators Driven by High-Torque Squirrel-Cage Motors

The main magnetic contactor on the Bulletin 9716 semi-magnetic controller panel is equipped with standard carbon-to-copper contacts. For sizes above 3 hp., powerful magnetic blowouts are supplied. Connections are so arranged that all arcing is handled by the contactor; this relieves the reversing drum switch of this duty.



Semi-Magnetic Control Panel Equipped with 200-Ampere Contactor. The Complete Controller (Bulletin 9716) Includes a Type "M" Reversing Switch

The reversing switch is rugged in construction and is enclosed in a drum type case. Standard C-H drum type fingers and segments are mounted on square steel insulated shafts. The mountings are such that metallic dust cannot cause short-circuits or partial grounds. The terminal connections are near the top of the case and are readily accessible.

If this controller is used on a winding drum type elevator, the traveling nut on the elevator machine should be arranged to throw the drum reversing switch to the "off" position at the normal limits of travel. For traction type elevator machines two hoistway limit switches may be used for obtaining the terminal stops.

All controllers of this type are arranged for the operation of either a single-phase or a polyphase magnetic brake. When such a brake is installed, hoistway limit switches are recommended in place of the more expensive traveling-nut device. In any case, all installations should include two hoistway limit switches to prevent overtravel of the elevator.

In order to prevent the automatic starting of the elevator upon resumption of voltage after failure, when the shipper mechanism is left in the running position, a low-voltage protective relay should be added to the standard equipment (two relays on two-phase, four-wire installations). This relay will also prevent the starting of the elevator car upon the closure of a gate or door, where door switches are used, without first moving the drum reversing switch to the neutral and then to the running position.

BULLETIN 9717

For Slow-Speed Elevators Driven by High-Torque Squirrel-Cage Motors

This controller practically duplicates Bulletin 9716, except that the drum reverse switch and magnetic panel are mounted together in one unit, and the added features of phase-failure and reversal protection as well as low-voltage protection are provided as standard.

It is built in sizes up to 15 hp., 220-550 volts. The frame is of the floor type and the drum is mounted on top with the shaft projecting to the rear for convenient mounting of the sheave wheel. Extensions to the rear of the frame provide stops for the sheave wheel by means of an extended lug. The center portion is notched so that the "run" and "off" positions are readily felt by the operator.

The "M" drum is always furnished because the smaller drum is not strong enough to carry the sheave wheel without an outboard bearing, a very undesirable feature.

This controller, which is shown on page 11, may be furnished with or without the sheave wheel.

BULLETIN 9776

For Slow-Speed Elevators Driven by Slip-Ring Induction Motors

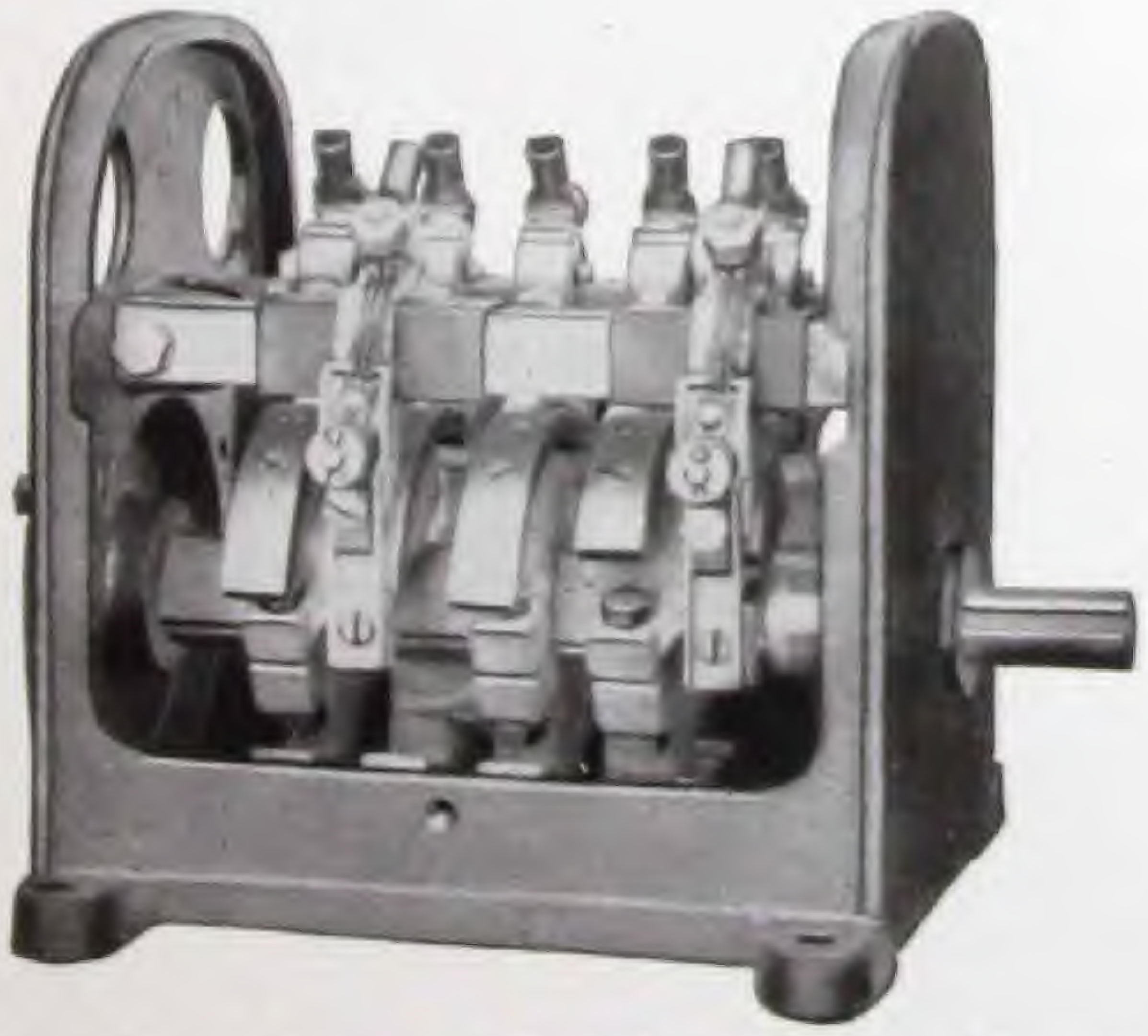
The Bulletin 9776 semi-magnetic controller consists of an automatic starter and a separately mounted reversing switch. Motor acceleration is controlled by an adjustable time-limit relay. When the dashpot on this relay is once set, the starter will always cut out the resistor in the same length of time.

The main magnetic contactor is of standard construction and similar to that already described under Bulletin 9716. Connections are so arranged that the arcing is handled by the contactor, which is provided with powerful magnetic blowouts.

The accelerating relay on the automatic starter operates the pilot-circuit contacts of the accelerating contactors. Type A has two double-pole accelerating contactors and provides three steps of acceleration. Type B has three double-pole accelerating contactors and provides four steps of acceleration.

The reversing switch is rugged in construction and is enclosed in a drum type case. Standard C-H drum type fingers and segments are mounted on square steel insulated shafts. The mountings are such that metallic dust cannot cause short-circuits or partial grounds. The terminal connections are near the top of the case and are readily accessible.

If this controller is used on a winding drum type elevator, the traveling nut on the elevator machine should be arranged to throw the drum reversing switch to the "off" position at the normal limits of travel. For traction type elevator machines, two hoistway limit switches may be used for obtaining the terminal stops.



Drum Type Reversing Switch with Cover Removed

All controllers of this type are arranged for the operation of either a single-phase or a polyphase magnetic brake. When such a brake is installed, hoistway limit switches are recommended in place of the more expensive traveling-nut device. In any case, all installations should include two hoistway limit switches to prevent overtravel of the elevator.

In order to prevent the automatic starting of the elevator upon resumption of voltage after failure, when the shipper mechanism is left in the running position, a low-voltage protective relay should be added to the standard equipment (two relays on two-phase, four-wire installations). This relay will also prevent the starting of the elevator car upon the closure of a gate or door, where door switches are used, without first moving the drum reversing switch to the neutral and then to the running position.

Semi-Magnetic Control Panel for Use With Single-Speed Slip-Ring Induction Motors. The Complete Controller (Bulletin 9776) Includes a Type "M" Reversing Switch

For some installations it is advantageous to have the starting panel and the reversing switch combined in one unit. The reversing switch is mounted on the top of the starting panel with a shaft extention projecting to the rear. For these combination units, the starting panel is mounted on a floor type frame.

Cutler-Hammer Elevator Control Accessories

The accessory equipment described on the following pages is designed for the safe, efficient and convenient control of elevators. The devices are intended to guard against all contingencies and leave as little as possible to the discretion of the operator or to his presence of mind in case of a service interruption.

Each device is as simple, rugged and dependable as it is possible to make it consistent with accurate, sensitive operation. The number of parts used has been kept at a minimum, thereby eliminating many possible sources of trouble.

All parts are compactly assembled and those designed for use in or about the elevator cars are available in a number of different finishes to harmonize with the finishes used by elevator builders.

Phase-Failure and Reversal Relays

BULLETIN 10081

The C-H Phase-Failure and Phase-Reversal Relay prevents the motor from being started if the phases are accidently reversed. This means that the elevator car cannot be started in a direction opposite to that which the operator expects it to move. The relay will also stop the motor in case of phase failure due to the opening of the supply line at any point, providing the motor is carrying a sufficient load to cause overheating when running single phase. The relay will not operate until the load increases to a harmful point or until an attempt is made to start the motor after stopping.

Bulletin 10081 should be arranged to operate through a main magnetic contactor. The principle of operation is similar to that of an induction disc wattmeter. A mercury switch opens and closes the control circuit and is so arranged that it makes the relay very sensitive to phase unbalancing, and yet the entire construction is remarkably rugged and dependable. The assembly of parts is very compact. Standard relays can be used without modification on either two or three-phase circuits. No transformers are required on any circuit up to and including 550 volts. A change of voltage or frequency merely means the change of two small coils.

Bulletin 10081 Phase-Failure and Reverse Relay with Cover Removed

Elevator Car Switches

BULLETIN 10305

Type "A" Car-Operating Switch for Single-Speed Installations

C-H Elevator Car Switches are provided with operating handles which are self-centering. The Type "A" Switch is equipped with a gravity return mechanism, while the Type "B" switch is equipped with a spring return mechanism.

The Type "A" switch has sufficient contacts for single-speed control and slow-down on direct-current installations and for single-speed control only on alternating-current installations.

The Type "B" switch has contacts for three speeds forward and reverse, and for over-load reset. It is provided with a star wheel to enable the operator to "feel" the operating handle in the different speed positions.

Both types of C-H car switches are provided with hand-operated latches which make it impossible to accidently start the elevator. The contact fingers are of standard C-H construction, being rugged in design and easily renewed.

Type "B" Elevator Car Switch

Rotating-Cam Machine-Limit Devices

BULLETIN 10310

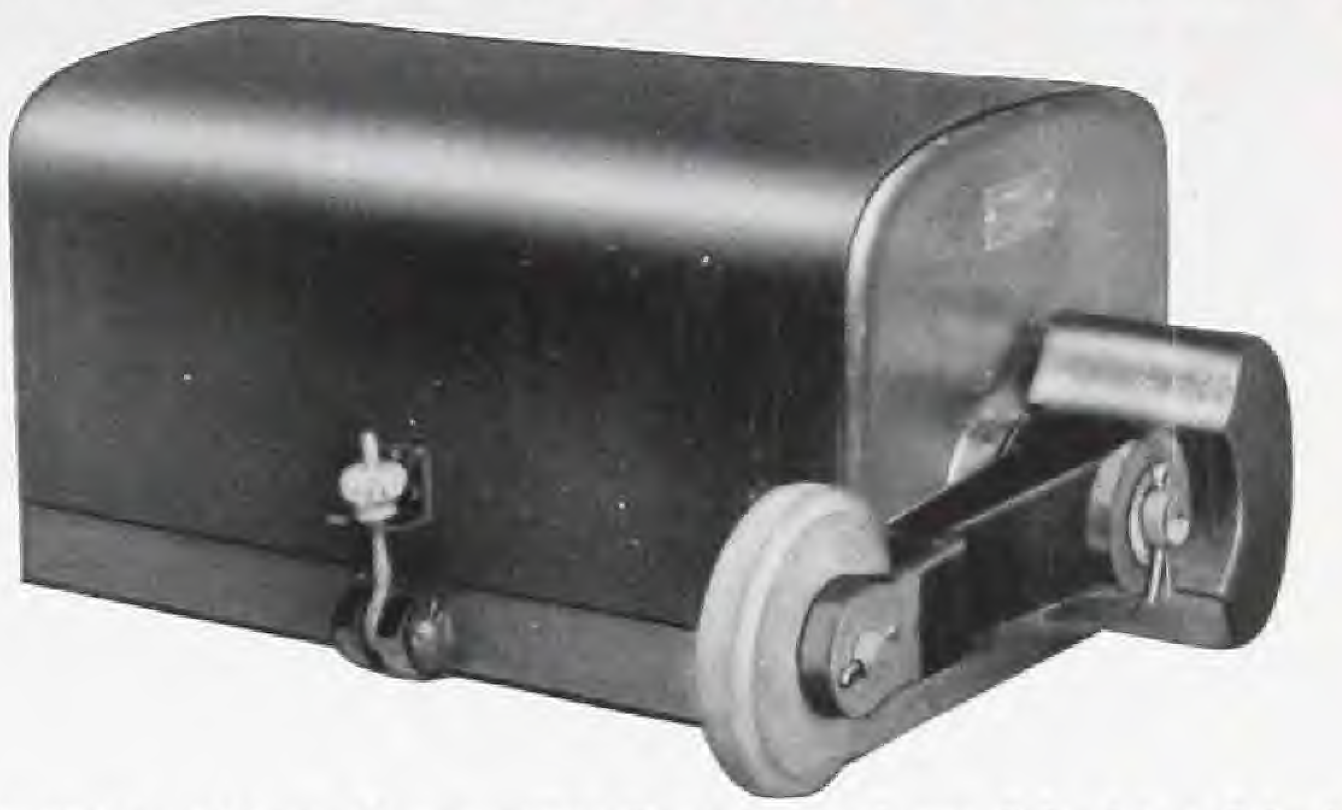
C-H Rotating-Cam Machine-Limit Devices are designed for operation with full-magnetic controllers. There are two types. Type "A" is used with a winding drum type elevator only. Type "B" is used with either a traction or drum type elevator.

The type "A" limit device is connected with the traveling-nut mechanism of the winding drum and opens the control circuits of the magnetic contactors on the elevator controller. The device provides automatic slow-down and stop at the terminal landings if the controller has the slow-down feature.

A centering device must be provided which will return the limit device and the yoke of the traveling-unit mechanism to the central position whenever the car moves away from either limit of travel.

Bulletin 10310 Type "A" Rotating-Cam Machine-Limit Device with Cover Removed

The type "B" limit device is designed primarily to replace hoistway limit switches. If slow-down is used, Bulletin 10310 Type "B" limit switch may be used for both the terminal stops and the slow-down stop in place of the Bulletin 10315 limit switches specified.



Bulletin 10310 Type "B" Rotating-Cam Machine-Limit Device, Showing Operating Lever

The type "B" limit device is arranged for mounting on the crosshead of the elevator car and is operated by two long cams in the hoistway, one for each limit of travel. These cams engage the lever on the operating shaft and rotate the latter sufficiently at each limit of travel to trip the pilot switches and open the control circuit. If the elevator controller has the slow-down feature the device automatically slows down the elevator before stopping it. The device is self-centering by means of a centering mechanism within the case.

Traveling-Cam Machine-Limit Devices

BULLETIN 10312

C-H Traveling-Cam Machine Limit-Devices are used in connection with full-magnetic elevator controllers on winding drum type elevators.

Bulletin 10312 Traveling-Cam Machine-Limit Device

The device combines the functions of the ordinary traveling-nut device and a machine-limit switch. It is geared directly to the shaft of the elevator winding drum. The traveling cam or nut is driven along the length of the threaded shaft as the car moves from one limit of travel to the other. As it reaches either limit the traveling nut trips the double pole snap switches. Two double-pole snap switches are provided for each direction of travel. They are the quick break type, adjustable as to position along the threaded shaft and arranged so that they can be locked positively when located. If the elevator controller is provided with the slow-down feature, two of the switches may be used for this purpose, one for each direction of travel.

Standard C-H construction is used throughout. The traveling nut is equipped with a grease cup to supply the necessary lubrication.

Hoistway Limit Switches

BULLETIN 10315

Bulletin 10315
Hoistway Limit
Switch

C-H Hoistway Limit Switches are used to open the control circuit of the main magnetic contactor on a semi-magnetic or a full-magnetic elevator controller. When the car goes beyond its limits of normal travel a cam mounted on the elevator car or on the counterweight engages with the wheel which opens the limit switch. The latter switch, in turn, opens the control circuit to the main magnetic contactor and stops the elevator. At least two switches are always necessary. They are usually mounted in the hoistway in such a manner that one is operated by the elevator car and the other by the counterweight. This arrangement locates both switches at one end of the hoistway and simplifies the wiring. Hoistway limit switches must be used in place of limit switches geared to the elevator machine on traction type elevators and may be used in place of machine type limit switches on drum type elevators. They should be installed with the wheel extending downward so that any loose material dropping down the hatchway will not be caught between the roller and the wall, and prevent operation or cause destruction of the switch when the cam engages with the wheel.

C-H Bulletin 10315 is a hoistway limit switch of the double-pole enclosed type. It is recommended for passenger service particularly, because it opens both sides of the control circuit and insures the stopping of the elevator motor even though one of the control lines may become grounded. Contacts are very rugged and are easily renewed when worn. The roller is rubber-tired.

Slack-Cable Switches

BULLETIN 10320

C-H Slack-Cable Switch, Bulletin 10320, is similar to Bulletin 10315 described above, except for the fact that a latch is provided so that, when tripped, the contacts remain open until reset by hand. The switch is used on drum type elevators and on traction elevators over ten or fifteen stories. It opens the main contactor on either semi-magnetic or full magnetic elevator controllers, should the cable become slack either because the car or the counterweight is caught in the guides. When no slack-cable switch is used considerable cable may become unwound before the operator has an opportunity to shut off the power. The car might then release itself, drop and break the cable. With a C-H Slack Cable Switch the possibility of such an accident is eliminated.

Mechanical connection is made to either end of the switch shaft or to the socket in the center of the shaft. When the elevator cable becomes slack, the movement of the shaft through a small angle trips the switch with a quick snap and opens both sides of the control circuit. A movement of $1\frac{1}{8}$ inches at a 10-inch radius from the center line of the shaft will trip the switch.

The switch is not provided with an automatic reset, so that after opening it is necessary for the operator to go to the machine room to reset it. This hand-resetting feature insures inspection of the machine and correction of the trouble before the elevator can be started again.

Bulletin 10320
Slack-Cable
Switch

Elevator Car Safety Switches

BULLETIN 10325

Bulletin 10325
Car Safety Switch

C-H Elevator Car Safety Switches are enclosed in suitable cast-iron cases designed for mounting in the elevator cab adjacent to the car switch. The switch itself is a rugged single-pole knife switch. It is connected in the control circuit on the side of opposite polarity to the car switch and insures a safe stop regardless of any possible combination of grounds. A separate two-wire car-control cable connects the switch with the control panel. Any grounds which are of a sufficiently serious nature to interfere with the operation of both the car switch and the safety switch will render the elevator equipment itself inoperative.

Hoistway Door Interlocks and Electric Contacts

BULLETIN 10326

These combination hoistway door interlocks and electric contacts are used to prevent the starting of the elevator car before the door is closed and locked. They interpose a break in the control circuit of the magnetic main contactor when the door is open, and complete the control circuit only when the elevator door is positively closed and locked.

The Type "A" interlock is designed for use on all push-button-operated elevators and on such car-switch-operated elevators where it is desired to prevent the operator from opening the door until the car is within a certain number of inches of the landing. A cam must be mounted on the elevator car in order to operate the rubber-tired roller. The switch is held open by gravity due to the weight of the roller. It can be furnished assembled for either a right or left-hand closing door. Provision is made for adjusting the Type "A" switch to compensate for variations in the opening in the hoistway. Adjustments can also be made in the other direction to properly place the roller for the position of the cam on the car.

The Type "B" interlock is for use with car-switch-operated elevators. It is identical with the Type "A", except that the roller mechanism is removed. No cam is required on the elevator car. The functions of the Type "B" interlock are simply those of a door electric contact, that is, the control circuit is broken when the door is unlocked. The Type "B" interlock is also held open by gravity.

These interlocks can be assembled for use with either right or left-hand closing hoistway doors. The interlock assembled for right-hand operation is the standard for each type and will be furnished that way unless specifically ordered for left-hand operation. However, these inter-

Bulletin 10326 Hoistway Door Interlock and Electric Contact with Covers Removed; Type "B" Shown at the Left and Type "A" at the Right

locks can very easily be changed over from one method of operation to the other.

The switch mechanism used with these interlocks employs normally closed single-pole, double-break contacts. These contacts are very rugged and easily renewed. The only springs used are those necessary to maintain adequate contact tension of the fingers. The entire structure is enclosed in a compact metal case. It is impossible to touch live parts unless the cover is removed. Provision is made at the top of the case for conduit entrance and for convenient arrangement of the wiring.

The latch for the door is not furnished in connection with these hoistway door interlocks and electric contacts.

Elevator Door Electric Contacts

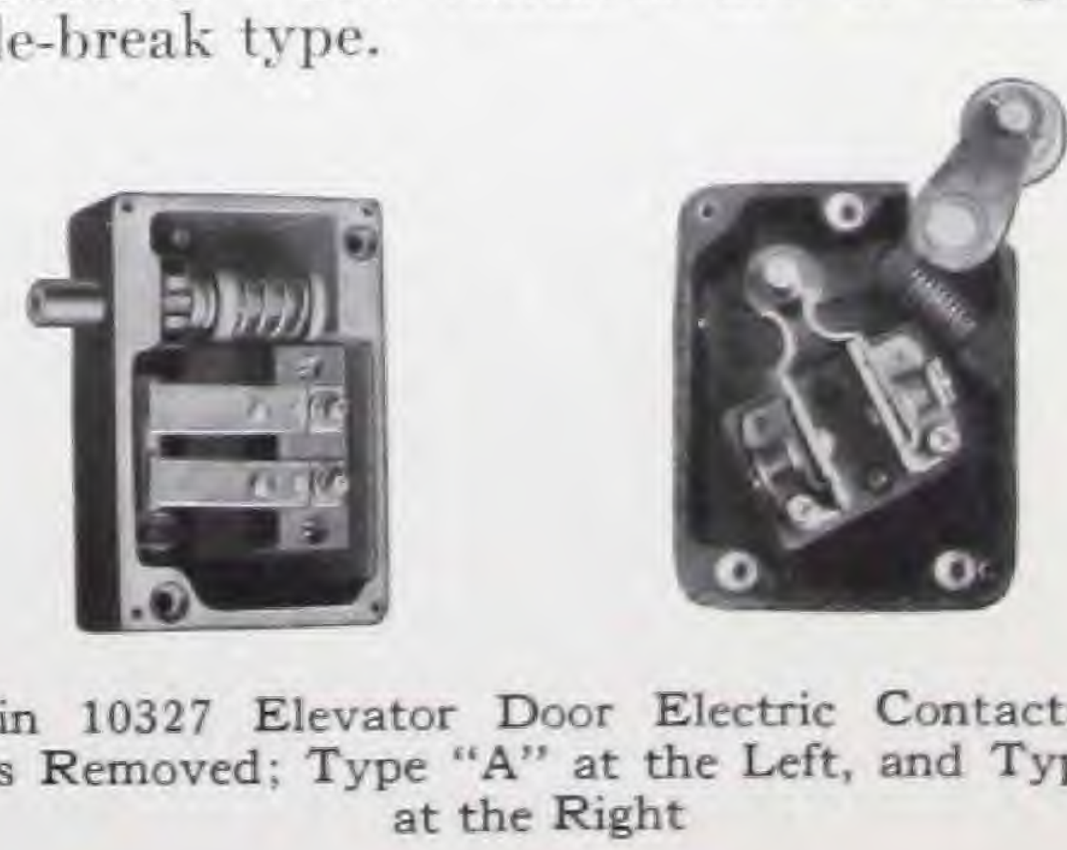
BULLETIN 10327

C-H Elevator Door Electric Contacts are employed to prevent the starting of the elevator car before all doors are closed. Two types, "A" and "B", are provided. Either type interposes a break in the control circuit of the main magnetic contactor when the door is open and completes the circuit when the door is closed.

Type "A" electric contact is generally used where space limitations compel the installation of a small switch. It is operated by a push button which engages the end of the sliding door.

Type "B" electric contact is used wherever space limitations will permit. It is operated by a lever and roller which engages with a cam on the sliding door.

Either type of C-H elevator door electric contact may be used with wheel, lever or rope-operated elevators if a main magnetic contactor is used to control the main line current. Both types are compact in design and dependable in construction. The contacts are of single-pole double-break type.



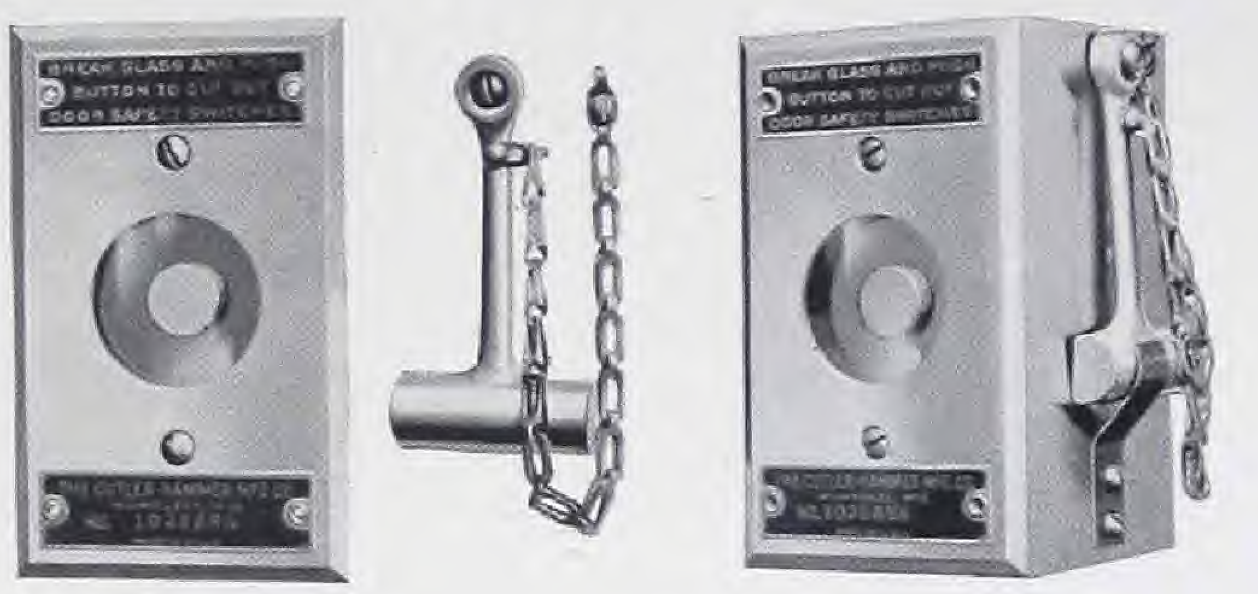
Bulletin 10327 Elevator Door Electric Contacts with Covers Removed; Type "A" at the Left, and Type "B" at the Right

Emergency Releases

BULLETIN 10328

The Type "A" flush mounted release consists of a normally open push-button mechanism with adapter casting for mounting in a standard flush outlet box. (The outlet box is not furnished.)

A flush type brass plate is mounted over the button with a piece of glass between the button and the plate. A small brass hammer with chain and mounting parts is supplied for attaching to the elevator car adjacent to the switching device.



Bulletin 10328 Emergency Releases; Type "A" Shown at the Right, and Type "B" at the Left

The Type "B" surface mounting release consists simply of mounting all the parts mentioned under Type "A" in a solid brass surface type box.

The design is such that the plate may be removed in order to replace a broken glass without coming in contact with live parts. The device is made practically of solid brass and has a brush brass finish as standard.

This emergency release is used to short-circuit the hoistway door electric contacts in case of emergency such as fire or upon failure of a hoistway door electric contact to make proper contact when the door is closed.

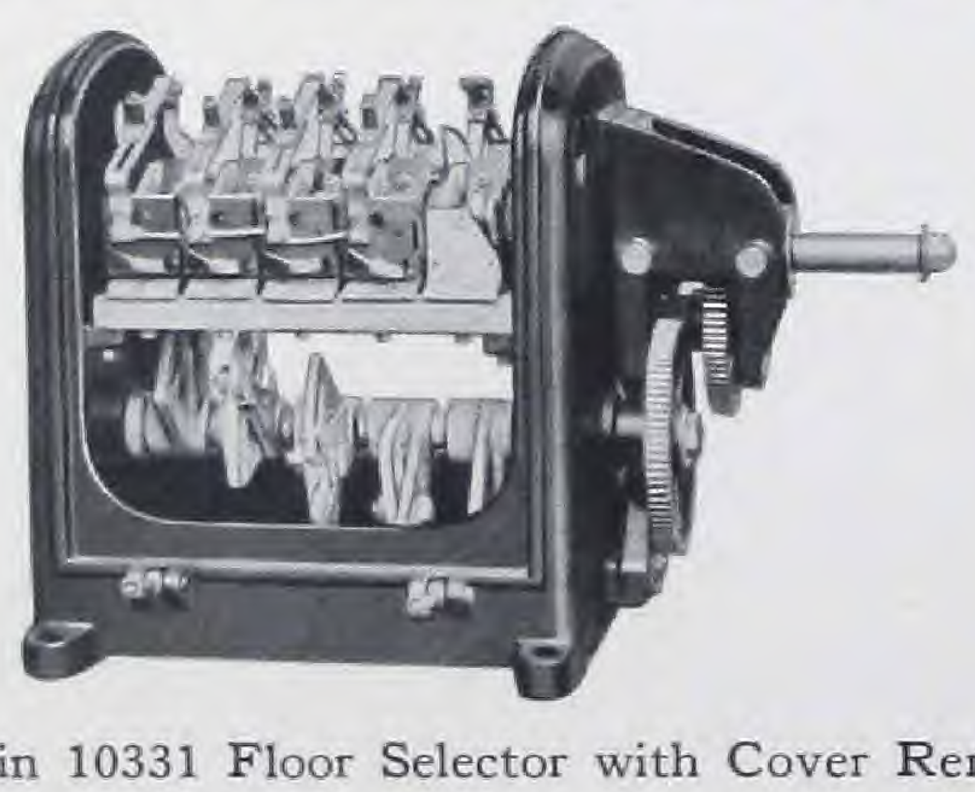
Breaking the glass by means of a small hammer and depressing the normally open contact button short-circuits the door electric contacts and allows the elevator to be operated. It is necessary for the operator to hold this button depressed while operating the elevator under emergency conditions. It is therefore necessary to install this release within easy reach from the car switch.

The Type "A" release is designed for flush mounting, and the Type "B" for surface mounting.

Floor Selectors

BULLETIN 10331

C-H Floor Selector, Bulletin 10331, is a machine type limit switch designed for use on push-button operated elevators and on dumb waiters. It determines the proper direction of travel and stops the elevator at the desired landing. For drum type elevators it may be geared directly to the winding drum shaft. For traction type elevators, however, a small winding drum or sprocket drive is geared to the selector. The accuracy of stop will not be disturbed by the shifting of the traction cable on the driving sheave.



Bulletin 10331 Floor Selector with Cover Removed

The selectors are of the drum type and operate through the proper number of control relays.

They are arranged for slow-down and controllers which provide this feature are recommended.

Control relays which operate in connection with the floor selector are mounted on the elevator control panel. They are of standard construction and require very little attention. Pushing the button for the floor desired closes the corresponding relay; this, in turn, operates the control equipment. When the car reaches the desired floor, the pilot circuit to the relay is broken by the selector and the car comes to a stop.

The floor selector can be furnished with or without the gearing.

The emergency stop feature which provides for the stopping of the car anywhere in its travel upon pushing the stop button in the car is necessary on push-button-operated passenger and freight elevators. This feature can also be obtained on the individual landing push buttons when the equipment is used for dumb waiters.

Bulletin 10331 Floor Selector Switch

Elevator Push-Button Switches

BULLETIN 10335

C-H Elevator Push-Button Switches are designed for elevator service. They are manufactured in both the surface type and the flush type. The surface type switch is a self-contained unit with the buttons mounted in a depression on the case to prevent accidental operation. The flush type switch is designed for mounting in a standard punched outlet box. As in the case of the surface type, the buttons are mounted in a depression in the case to guard against accidental operation. Provision is made for conduit mounting in either the bottom or rear of the case up to and including the four-button switch. The larger sizes are provided with conduit entrances at the rear only. Standard markings for buttons include numerals from 1 to 12, with or without the letter "B" in combination, or the words, "On," "Off" "Start," "Up," and "Down."

Bulletin 10335 Switch, Surface Type

Brake Magnets for Direct-Current Service

BULLETIN 10340

Bulletin 10340 Brake Magnet

C-H Brake Magnets, Bulletin 10340, are designed for use in connection with control panels for electric elevators to operate the brake. Substantially made to withstand the severe demands of this class of service, these magnets are manufactured in two types for long-pull and for short-pull operation, the length of stroke varying from 1 to 3 inches for the long-pull magnets and from $\frac{1}{4}$ to $\frac{1}{2}$ inch for the short-pull magnets. Both types are made with shunt-wound and with compound-wound coils in order to provide magnets with different ratings of pull in pounds. The two coils of a compound-wound magnet are mounted in the same frame. The series coil is short-circuited by the controller as soon as the brake is released so that only the shunt-wound coil holds the brake clear.

The coils are of liberal design and are suitable for intermittent service. Coils for continuous duty can be furnished when specified, but the pulls obtainable are only about one-half of those obtainable with coils for intermittent duty.

Single-Phase Brake Magnets

BULLETIN 10345

C-H Single-Phase Brake Magnets, Bulletin 10345, may be used to operate brake menhanisms on any type of alternating-current elevator. The brakes are designed and built for heavy service. The pull is practically constant throughout the entire stroke.

In selecting a single-phase brake magnet it is important that the magnet selected should be neither too large nor too small for the brake. If the magnet has considerable excess power there is a tendency for the plunger to pull in with an excessive hammer blow. This makes it noisy in operation and puts undue strain on the system, and a larger amount of power than is necessary is required to operate the magnet.

Particular care should be exercised in mounting these magnets on the brake menhanism to avoid side strain on the plunger, which prevents its sealing squarely against the plug and causes a a chattering noise in operation.

In order to obtain the best results and insure quiet operation the magnet should be immersed in a cast iron oil-pot. These pots are usually supplied as a part of the elevator brake mechanism. They are not furnished with Bulletin 10345 magnets.

Bulletin 10345 Single-Phase Brake Magnet Installed for Operation of Elevator Brake

Elevator Hoistway Junction Boxes

Elevator Hoistway Junction Box

The elevator hoistway junction box is suitable for all car-switch installations and for push-button control up to six landings. Above six landings for push-button control two boxes are required.

The box is made of sheet iron, approximately 14 inches long by $8\frac{1}{4}$ inches wide and 3 inches deep, and contains an asbestos lumber terminal board on which are mounted fifteen terminals.

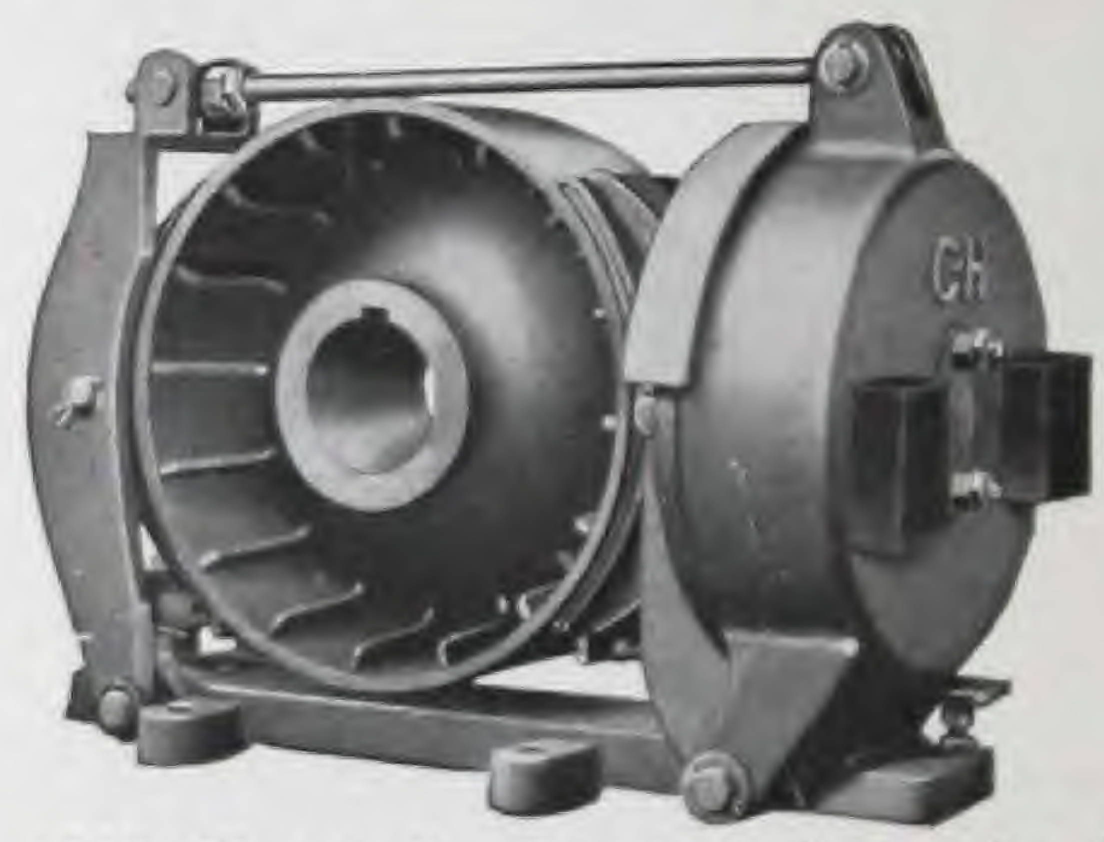
The terminals are so spaced as to conform with the Underwriters' specifications for 600 volts. They are so constructed that they will not turn when terminal screws are removed.

Knock-out holes are provided on all sides. They are arranged to take care of several sizes of conduit fittings, as holes are provided of $1\frac{11}{16}$-inch diameter, $1\frac{3}{8}$-inch diameter and $1\frac{1}{16}$-inch diameter.

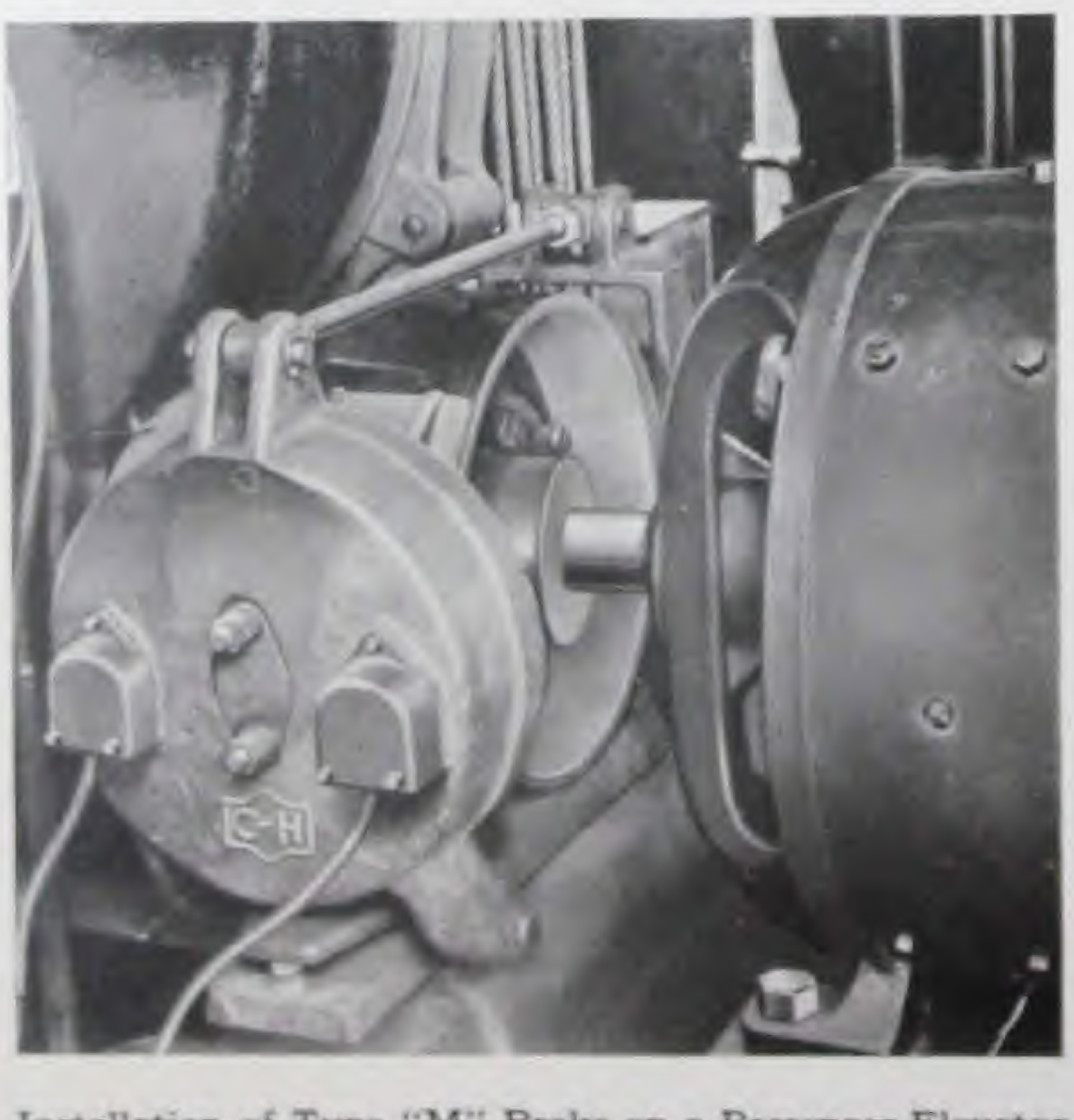
Type "M" Brakes for Direct-Current Service

In Type "M" Brakes are combined a number of features which are of particular importance in elevator service. The direct magnet action eliminates all toggles, bell cranks and levers ordinarily required to change the direction or amplitude of the actuating force. There is no lost motion and very little friction. The short stroke of the magnet insures quick, quiet action, with an entire absence of shock on setting or hammer on release. The simplicity of the design and the rugged steel structure insure minimum maintenance and a maximum life. The compact design permits installation where only a small amount of space is available.

The arrangement of parts is such that the operating magnet acts directly on the brake shoes.



Type "M" Electrically Operated Brake for Direct-Current Service



Installation of Type "M" Brake on a Passenger-Elevator Motor

The magnet armature is an integral part of one of the brake-shoe arms and the magnet field is connected to the opposite shoe arm by a rod, which passes over the brake wheel. When the brake is applied, the armature and field are forced apart by the spring located in the center of the magnet field. The brake shoe attached to the armature is forced against the wheel. At the same time the magnet field pulls the opposite shoe against the wheel. In brief, each shoe moves the same distance and in exactly the same direction as does that part of the magnet to which it is attached. The action and reaction of the armature and field are equal, and equal forces are bound to be exerted on the two brake shoes. The operation of the brake is direct; there is no lost motion, very little friction and the action is remarkably snappy.

The direct action between the operating magnet and the brake shoes makes the use of a short-stroke magnet possible. The total movement between the armature and field is not over one-eighth inch or one-sixteenth inch for each shoe. This results in practically instantaneous application and release, and the distance traveled is so

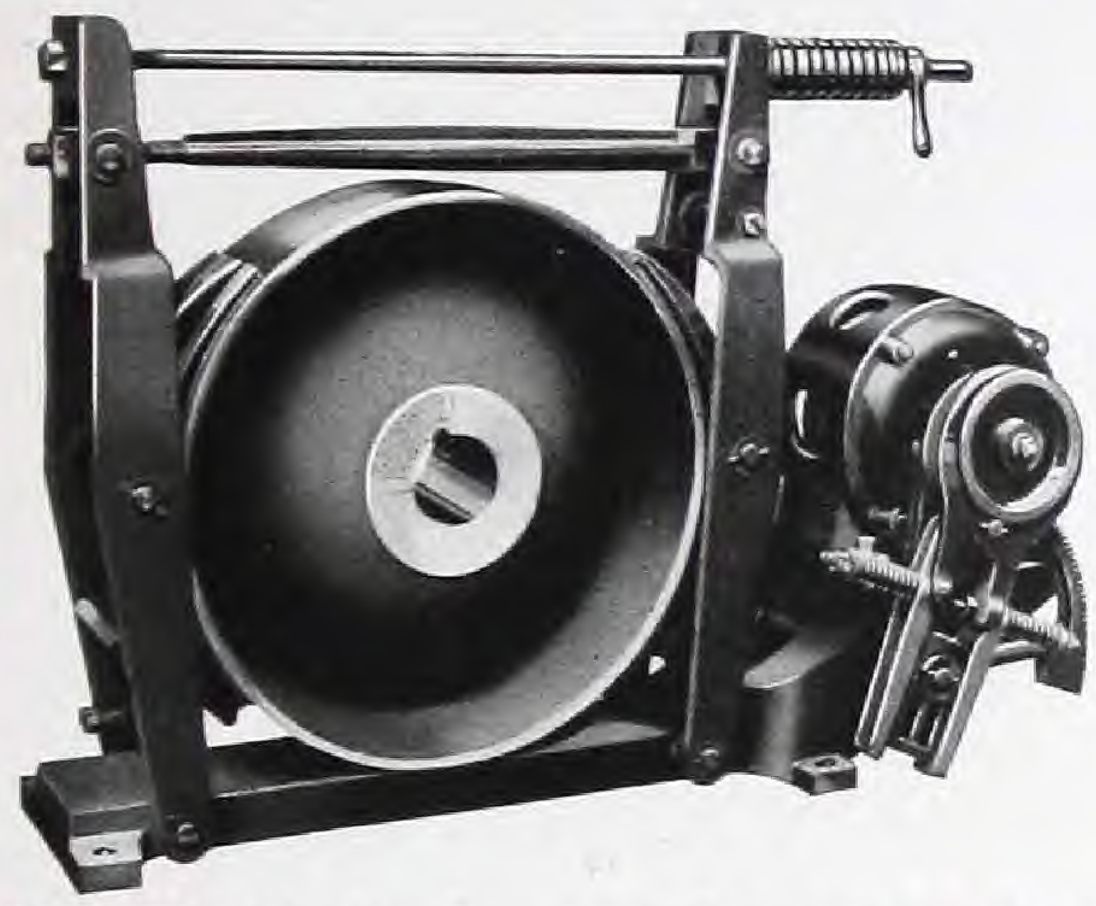
short that there is no chance for bouncing on application or hammer blow on release. There is no dragging of the brake shoes as the motor gets under way and no undue wear on the brake shoe linings.

All working parts of Type "M" Brakes are made of heavy cast steel to insure against breakage. There are no fragile parts and nothing to get out of adjustment and cause faulty action. The brake wheel is built with a special hub which eliminates heat strains and provides great strength in the keyway.

The intensity of the braking force is regulated by varying the compression on the large helical spring in the center of the magnet field. Adjustment for wear on the brake-shoe linings is made by changing the effective length of the rod above the brake wheel.

Type "RS" Brakes for Alternating-Current Service

Type "RS" Brakes possess unusual advantages for elevator work. Briefly, these special advantages include maximum safety, a minimum of noise, a smooth application of the braking pressure



Type "RS" Electrically Operated Brake for Alternating-Current Service

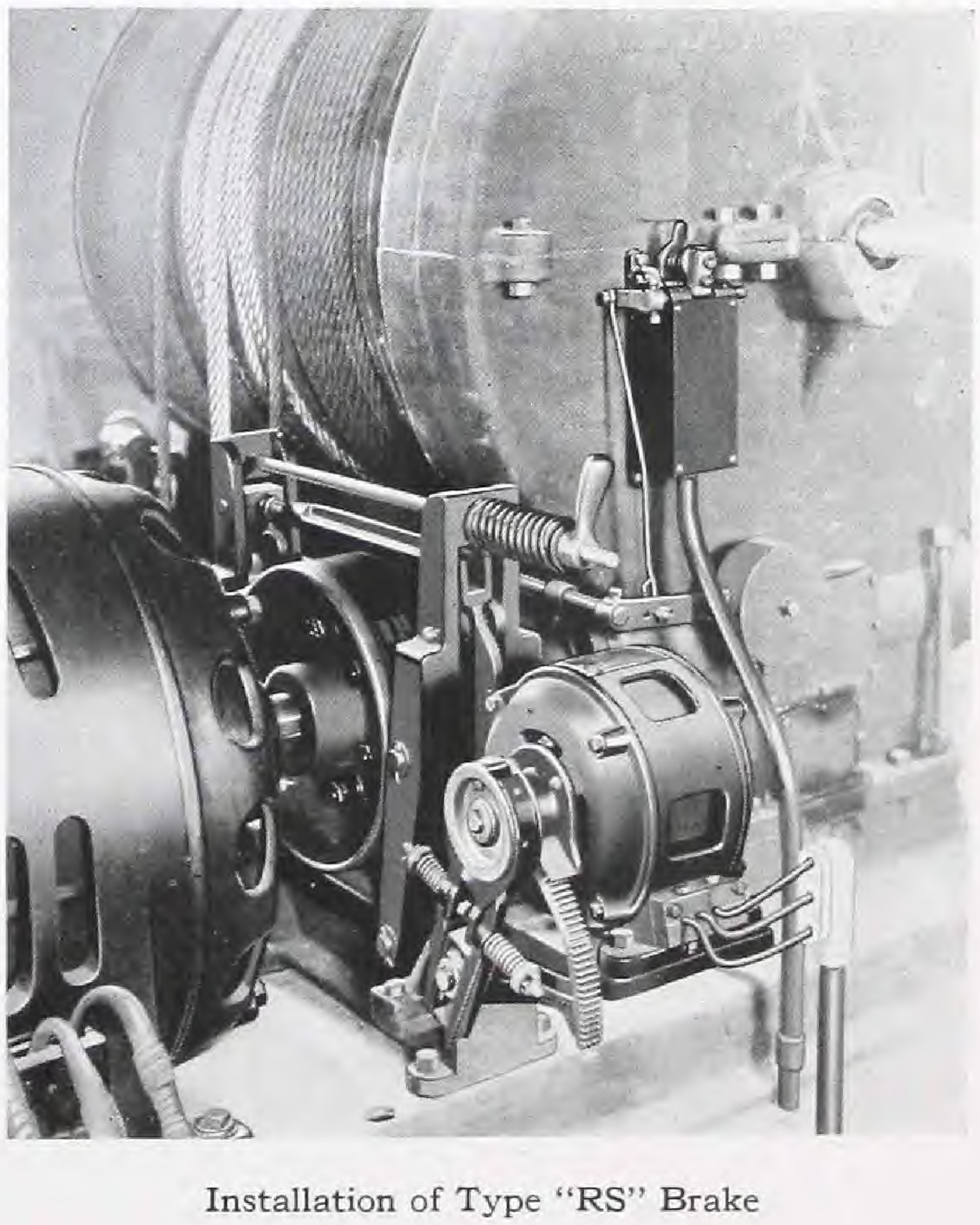
and no current surges to disturb the line or cause coil burnouts.

A Type "RS" Brake is operated by a rotating magnet in place of the ordinary solenoid or clapper magnet. The rotor operates through a pinion and a toothed sector to which a lever is attached. This lever spreads the brake arms and releases the brake shoes as the rotor revolves. It requires only one and one-half revolutions of the rotor to release the brake, after which it stalls and holds the brake in the released position. When the brake is applied, a heavy helical spring forces the brake shoes against the wheel.

The design of these brakes is such that there is no mechanical contact between reacting members. The rotor and stator of the rotating magnet replace the armature and field of the customary solenoid or clapper magnet. It is entirely unnecessary to immerse the operating mechanism in oil to secure quiet operation.

Smooth steady application of brake pressure is secured by the special C-H method of connecting the rotating magnet to the brake shoes. The small rotor is so connected that it acts as an inertia governor to ease the shoes onto the wheel after which it overruns freely and does not affect the shoe pressure.

The rotating magnet draws a practically constant current from the line. The amount is small and does not disturb the voltage regulation. Moreover, the absence of any current inrush obviates any possible danger of burning out the magnet winding.



Installation of Type "RS" Brake

Standard Installations

Elevator Control Equipment for Use with Direct-Current Motors

The following control equipment is recommended for standard installations. For special conditions, certain changes in these lists may be desirable. C-H engineers will gladly assist in selecting equipment for special work.

I. Semi-Magnetic Control

1—Bulletin 7021 or 7022 Controller (If duty is heavy, Bulletin 7041) with low-voltage protection and with dynamic braking if the car speed exceeds 100 ft. per min.

2—Bulletin 10315 Hoistway Limit Switches for overtravel protection.

2—Bulletin 10315 Hoistway Limit Switches for terminal stops. (If a drum type elevator with traveling nut mechanism is used, the terminal stops may be obtained by arranging the traveling nut mechanism to return the drum to the "off" position at the terminal landings).

1—Bulletin 10320 Slack Cable Switch. (For drum type elevators).

1—Bulletin 10325 Car Safety Switch for emergency stop.

1—Bulletin 10326 Hoistway Door Interlock and Electric Contact or

1—Bulletin 10327 Door Electric Contact for each landing.

1—Bulletin 10327 Door Electric Contact for each car gate.

1—Bulletin 10328 Door Electric Contact Emergency Release.

1—Bulletin 10340 Brake Magnet or Type M Elevator Brake.

II. Car-Switch Control

A—Slow speed freight or passenger service (Not over 200 ft. per min.)

—Bulletin 7301 Controller. (Use slow-down and dynamic braking on car speeds above 100 ft. per min.)
Or Bulletin 7331 Controller single speed, if duty is severe.

1—Bulletin 10305 Car Operating Switch.

1—Bulletin 10310 Type A or Bulletin 10312 if for a drum type elevator.

2—Bulletin 10315 Hoistway Limit Switches for overtravel protection.

2—Bulletin 10315 Hoistway Limit Switches for terminal limits. (Traction type elevator).

2—Bulletin 10315 Hoistway Limit Switches for terminal slow-down. (Traction type elevator.) If slow-down is used, Bulletin 10310 Type B Limit Switch may be used for terminal stops in place of the Bulletin 10315 Limit Switches specified.

1—Bulletin 10320 Slack Cable Switch, if for a drum type elevator or for long travel lifts if traction type elevator is used.

1—Bulletin 10325 Car Safety Switch.

1—Bulletin 10326 Hoistway Door Interlock and Electric Contact or

1—Bulletin 10327 Door Electric Contact for each landing.

1—Bulletin 10327 Door Electric Contact for each car gate.

1—Bulletin 10328 Door Electric Contact Emergency Release.

1—Bulletin 10340 Brake Magnet or Type M Elevator Brake.

1—Hoistway Junction Box.

B—High speed passenger service.
Use Bulletin 7331 Two-Speed Controller in place of Bulletin 7301. Other equipment required will be the same as listed above under item "A". Graduated dynamic braking and a full field contactor are recommended for car speeds above 300 ft. per min.

III. Push-Button Control

A—Slow speed freight or passenger service; three landings or more; speed not over 175 ft. per min.

1—Bulletin 7301 Controller with slow-down, or Bulletin 7331 single or two-speed if the duty is severe.

2—Bulletin 10315 Hoistway Limit Switches for overtravel protection.

1—Bulletin 10320 Slack Cable Switch, if for drum type machine.

1—Bulletin 10326 Hoistway Door Interlock and Electric Contact or

1—Bulletin 10327 Door Electric Contact for each landing.

1—Bulletin 10327 Door Electric Contact for each car gate.

1—Bulletin 10328 Door Electric Contact Emergency Release.

1—Bulletin 10331 Floor Selector with slow-down.

1—Bulletin 10335 Call Push Button for each landing.

1—Bulletin 10335 Push Button Gang Switch.

1—Bulletin 10335 Emergency Stop Button.

1—Bulletin 10340 Brake Magnet or Type M Elevator Brake.

1—Hoistway Junction Box.

B—Slow speed freight or passenger service; two landings. (Not above 175 ft. per min.) Use the same equipment as listed under "A" except that the Floor Selector, Bulletin 10331, may be omitted and four Bulletin 10315 Hoistway Limit Switches substituted.

C—Dumb Waiters; three landings or more. (Not over 300 ft. per min.) Use the same equipment as listed under item "A" except for the omission of the Car Gate Switch, Bulletin 10327, Door Switch Emergency Release, Bulletin 10328, and the Bulletin 10335, Emergency Stop Push Button. Include one push button gang switch for each landing, each switch to have a control button for each landing (omit the gang switch from the car).

D—Dumb Waiters; two landings. (Not over 300 ft. per min.) Use the same equipment as specified under "C" but omit Hoistway Junction Box and the Bulletin 10331 Floor Selector and use four Bulletin 10315 Hoistway Limit Switches for obtaining terminal slow-down and stop functions.

E—High speed passenger service. (Not over 400 ft. per min.) Use the same equipment as listed under item "A" with this exception: Always use a Bulletin 7331, Two-Speed Controller in place of Bulletin 7301.

IV. Dual Control

Passenger or freight service. Use equipment listed under push button control, item "III A", "III B", or "III E" depending upon the speed and number of landings and include the following equipment:

1—Bulletin 10305 Car Switch,

2—Bulletin 10315 Hoistway Limit Switches for terminal stops on car switch control.

1—Bulletin 10325 Car Safety Switch. In addition to the above a multi-pole control circuit transfer switch is required to transfer the circuits from the car switch to the push button operation, and visa-versa. This transfer switch is usually mounted on the control panel.

Standard Installations of Elevator Control Equipment for Use with Alternating-Current Motors

I. Semi-Magnetic Control

1—Bulletin 9716 or 9717 Controller with low-voltage protection for squirrel cage motors, or

1—Bulletin 9776 Controller with low-voltage protection for slip ring motors.

1—Bulletin 10081 Phase Failure and Phase Reversal Relay.

2—Bulletin 10315 Hoistway Limit Switches for overtravel protection.

2—Bulletin 10315 Hoistway Limit Switches for terminal stops. (These are not necessary if a drum type elevator with traveling nut mechanism is used).

1—Bulletin 10320 Slack Cable Switch. (For drum type elevator).

1—Bulletin 10325 Car Safety Switch for emergency stop.

1—Bulletin 10326 Combination Door Interlock and Electric Contact or

1—Bulletin 10327 Door Electric Contact for each landing.

1—Bulletin 10327 Electric Contact for each car gate.

1—Bulletin 10328 Electric Contact Emergency Release.

1—Bulletin 10345 Brake Magnet or Type RS Elevator Brake.

II. Car-Switch Control

A—Slow speed freight or passenger service. (Not over 200 ft. per min.)

1—Bulletin 9841 Controller with overload protection and with or without primary resistor feature—for squirrel cage motor, or

1—Bulletin 9871 Controller with overload protection—for slip ring motor.

1—Bulletin 10081 Phase Failure and Phase Reversal Relay.

1—Bulletin 10305 Car Operating Switch.

1—Bulletin 10310 Type A, or Bulletin 10312 Limit Switch, if for drum type elevator.

2—Bulletin 10315 Hoistway Limit Switches for overtravel protection.

2—Bulletin 10315 Hoistway Limit Switches for terminal stops if traction elevator.

1—Bulletin 10320 Slack Cable Switch for drum type elevator or for long travel lifts on traction elevator.

1—Bulletin 10325 Car Safety Switch.

1—Bulletin 10327 Door Electric Contact for each landing door and for the car gate.

1—Bulletin 10326 Combination Door Interlock and Electric Contact, or

1—Bulletin 10327 Door Electric Contact for each landing.

1—Bulletin 10327 Door Electric Contact for each car gate.

1—Bulletin 10328 Door Switch Emergency Release.

1—Bulletin 10345 Brake Magnet or Type RS Elevator Brake.

1—Hoistway Junction Box.

B—High speed passenger service. (Not over 400 ft. per min.) This requires a special two-speed elevator motor (alternating current). Use the same equipment as outlined in item "A" except for the controller. This must be either Bulletin 9843 or Bulletin 9872 depending upon the type of motor. A "dynamic braking" governor may be provided to insure a quick smooth stop when the car switch is moved from the high speed to the neutral position.

III. Push-Button Control

A—Slow speed passenger or freight service; three landings or more. (Speed not to exceed 125 ft. per min.)

1—Bulletin 9841 Controller—for squirrel cage motor, or

1—Bulletin 9871 Controller—for slip ring motor.

1—Bulletin 10081 Phase Failure and Phase Reversal Relay.

2—Bulletin 10315 Hoistway Limit Switches for overtravel protection.

1—Bulletin 10320 Slack Cable Switch if a drum type elevator.

1—Bulletin 10326 Combination Door Interlock and Electric Contact, or

1—Bulletin 10327 Door Electric Contact for each landing.

1—Bulletin 10327 Door Electric Contact for each car gate.

1—Bulletin 10328 Door Electric Contact Emergency Release.

1—Bulletin 10331 Floor Selector without slow-down.

1—Bulletin 10335 Push Button Car Gang Switch.

1—Bulletin 10335 Call Push Button for each landing.

1—Bulletin 10335 Push Button Emergency Switch.

1—Bulletin 10345 Brake Magnet or Type RS Elevator Brake.

1—Hoistway Junction Box.

B—Slow speed passenger or freight service elevator; two landings. (Not over 125 ft. per min.) Use the same equipment as in item "A" except that the Floor Selector, Bulletin 10331, may be omitted and

2—Bulletin 10315 Hoistway Limit Switches substituted.

C—Dumb Waiters; three landings or more. (Not over 150 ft. per min.) Use the same equipment as under item "A" except for the omission of the Car Gate Switch Bulletin 10327, the Door Switch Emergency Release Bulletin 10328 the Hoistway Junction Box and the Emergency Stop Button, Bulletin 10335. Include one push button gang switch for each landing; each switch to have a control button for each landing, (omit the gang switch for the car).

D—Dumb Waiters; two landings. (Not over 150 ft. per min.) Use the same equipment as listed in item "C" with the omission of Bulletin 10331 Floor Selector and the addition of two Bulletin 10315 Hoistway Limit Switches for obtaining the terminal stops.

E—High speed passenger service and freight service where accurate stops are required. (Not over 400 ft. per min.) Use the same equipment as item "A" except always use a special two-speed elevator motor and either Bulletin 9843 or Bulletin 9872 depending upon the type of motor; also a Bulletin 10331 Floor Selector with slow-down is essential.

IV. Dual Control

Use the same equipment as under items IIIA, IIIB, or IIIE, depending upon the speed and number of landings, and add the following:

1—Bulletin 10305 Car Switch.

2—Bulletin 10315 Hoistway Limit Switches for terminal stops on car switch control.

1—Bulletin 10325 Car Safety Switch.

In addition to the above, a multi-polar control circuit transfer switch is required for the transfer of circuits from car switch to push button operation, and visa-versa. This is usually mounted on the control panel.

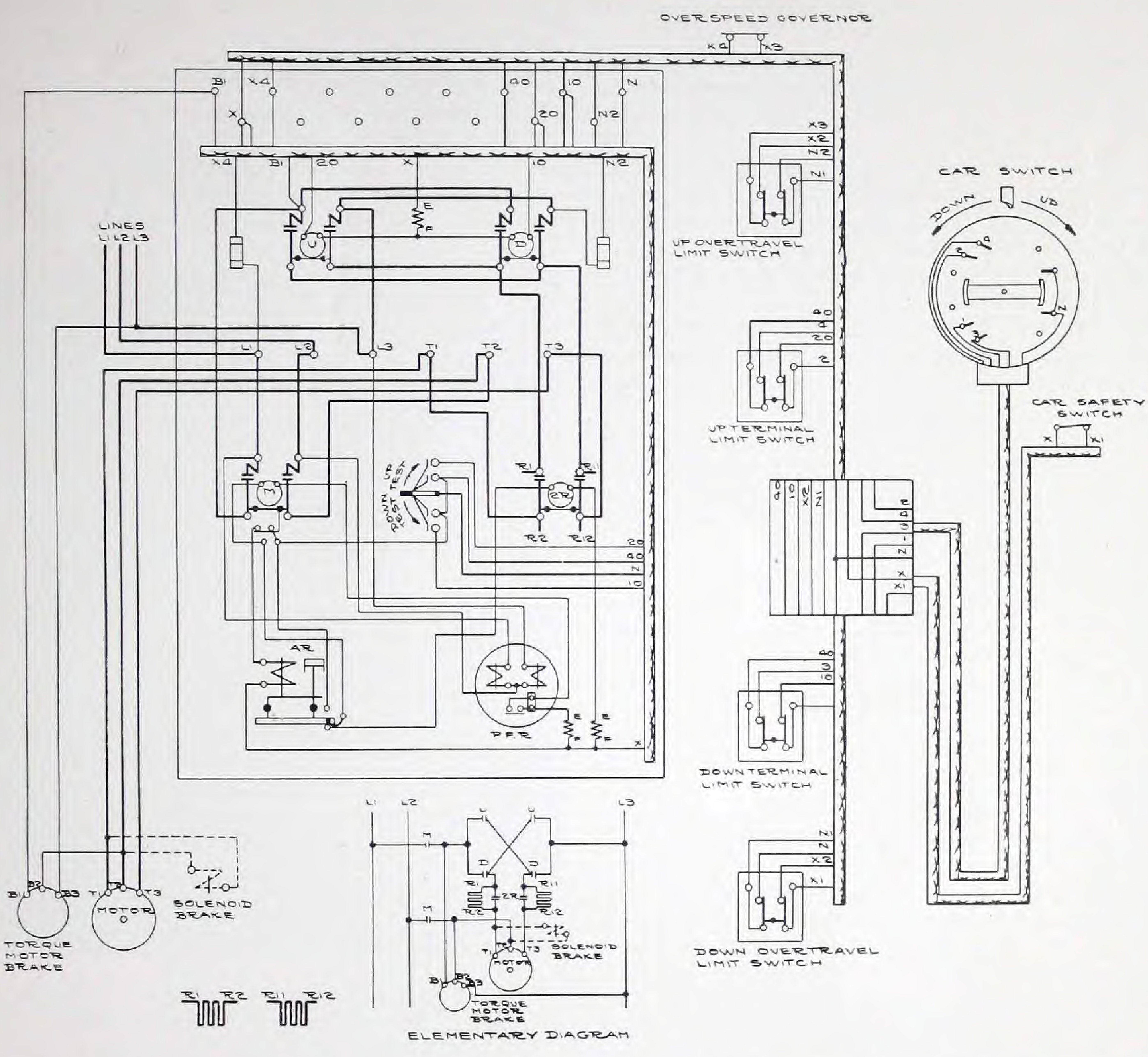
Installations of Variable-Voltage Elevator Controllers

(For High Speed Service)

The same accessories as listed under Elevator Control Equipment for use with Direct Current Motors II-A are required. See page 34.

In addition to the Elevator Controller a starter is required for the motor which drives the generator.

A Typical C-H Wiring Diagram



While this diagram shows the wiring for an alternating-current full-magnetic elevator controller for car-switch operation, it is typical of the diagrams which accompany all C-H Elevator Controllers. The lines are placed sufficiently far apart to enable the wiring circuits to be traced without confusion. An elementary diagram is always included. Overtravel and hoistway limit switches are shown on all diagrams. On drum machine control diagrams a slack-cable switch is shown. On alternating-current wiring diagrams the connections for both single-phase and poly-phase brakes are indicated. On direct-current diagrams connections for a compound-wound motor and a compound-wound brake magnet with the series windings cut out in one step after starting are shown. Optional connections for a shunt motor and a shunt brake are also placed on the diagram. Direct-current diagrams carry polarity signs, because of the fact that the carbon-to-copper contacts have much longer life when the current flows from the carbon to the copper.

On all diagrams for showing full-magnetic controllers control fuses are included. A try-out switch is shown, except on two-landing push-button installations and on three-landing dumb-waiter installations. The try-out switch is connected outside of the terminal limits, so that it is possible to run into the overtravel switches from the try-out switch. This method of connecting the try-out switch saves running four wires from the limit switches to the control panel. A single-pole overspeed governor contact is shown on all diagrams. The car safety switch is connected to the line whose polarity is opposite to that which is used for the car switch, and the connection is made by a separate cable.

Motors for Elevator Service

No matter how good an elevator controller may be, it is obvious that without the right type of motor the elevator service is bound to be unsatisfactory. A few suggestions regarding the selection of motors for elevator work may be helpful.

In order to insure rapid acceleration and retardation, the inertia of moving parts must be kept as low as possible. For this reason motors for elevator service are designed with armatures of comparatively small diameter. Slow-speed motors are preferable. Generally speaking, the motor speed should not exceed 900 revolutions per minute. Motor speed, of course, is not so important on slow-speed as on high-speed elevators.

Direct-Current Motors

For freight service compound-wound motors are recommended. The series winding provides a high starting torque—an essential factor for heavy duty work. With full-load current the compound winding should have from 10 to 15 percent of the ampere turns of the shunt field. By cutting out the series winding after starting, the motor becomes a constant-speed machine—the most desirable type for the varying loads encountered in elevator service. For passenger service, either compound-wound or shunt-wound motors give satisfactory results. For speeds above 200 feet per minute, motors of the variable speed type should be used. Between 200 and 350 feet per minute, a speed range by shunt field control of two to one is common. Above 350 feet per minute greater speed ranges are necessary to secure satisfactory operation. Many installations are now being made with three-to-one motors for car speeds of between 500 and 600 feet per minute.

When a dynamic braking controller is used the motor should be capable of commutating without difficulty dynamic braking currents whose values approximate 175 percent of the full-load current of the motor. Controllers which provide the dynamic braking feature also require a motor whose shunt field winding is capable of standing one-half the line voltage continuously without overheating with the motor armature at rest.

Alternating-Current Motors

Because of improvements in motor designs and through the use of properly designed controllers, many of the limitations which were formerly attributed to the use of alternating-current motors in elevator service have been successfully overcome. With the usual single-speed motor, it is still impossible to employ dynamic braking or anything equivalent to it. The elevator must be slowed down and stopped by the mechanical brake alone. Inasmuch as the energy stored in the moving parts is proportional to the square of the velocity and a mechanical brake is capable of absorbing this energy only in direct proportion to the velocity, this has limited alternating-current installations to relatively slow-speed installations.

As already outlined under the discussion of full-magnetic elevator controllers, alternating-current motors of the two-speed type are now available and are being used successfully on

Installation of Cutler-Hammer Two-Speed Alternating-Current Controller Arranged for Dual Control

elevators whose car speeds are as high as 400 feet per minute. The customary speed range is three to one, the motor being designed with two separate primary windings. Under normal conditions the motor is accelerated on the high-speed winding. The slow-speed winding is used for "inching" and in slowing down to make a landing. For this latter use, the slow-speed winding acts as a sort of dynamic brake and insures smoother retardation and a more accurate stop than would be possible with the customary alternating current motor. By using a C-H Elevator Controller and an automatic governor it is possible to secure automatic "dynamic braking" on this type of motor when the car switch is thrown from the high-speed to the "off" position without stopping at the slow-down position. The governor automatically provides dynamic braking in the "off" position of the car switch in case the motor is running above the synchronous speed of the slow-

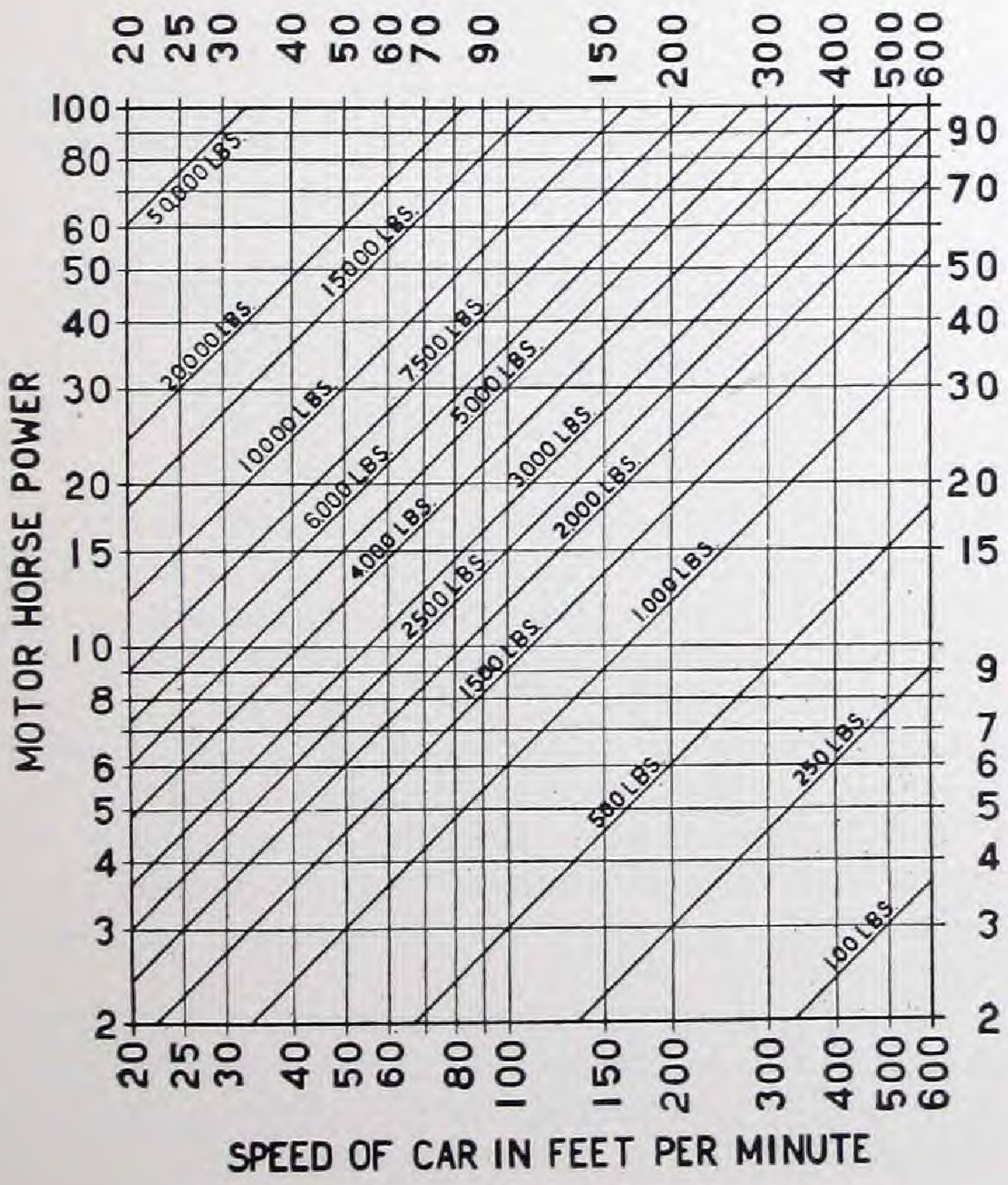
speed winding. The use of this governor eliminates the possibility of an extreme slide of the car.

As in direct-current service all alternating-current elevator motors should be designed especially for elevator work. The starting torque should be at least 225 percent of the rated full-load torque. Motors having more than approximately 15 percent variation in speed from no load to full load are not recommended for elevator service. Polyphase motors of both the slip-ring and squirrel-cage types give satisfactory results. A secondary resistor is used with slip-ring induction motors. Primary resistors are used with squirrel-cage motors to secure smooth acceleration. For slow-speed service the squirrel-cage motor is often thrown directly across the line. Motors of this type, when connected directly to the line, should not take more than two and one-half to three times normal full-load current.

Single-phase motors of the self-starting repulsion-induction type may also be used for elevator service. Single-phase motors of the standard split-phase or standard repulsion-induction type are not suitable for elevator service because of the uncertainty as to whether the motor will reverse when the connections are reversed quickly.

Calculation of Motor Rating

Three factors determine the horsepower of an elevator motor for any particular installation. These are the net weight to be hoisted, the speed of car travel and the efficiency of the elevator. In the accompanying diagram these three factors have been so arranged that the horsepower required for any elevator installation may be determined easily and quickly. In this chart the efficiency of the elevator is assumed to be



50 percent. The method of ascertaining the proper size of motor is as follows: Follow the diagonal line corresponding to the unbalanced load up to the point where it crosses the vertical line which represents the car speed desired. The horizontal line at this point will indicate the required horsepower of the motor.

If the efficiency of the elevator installation is known to be other than 50 percent, divide the horsepower obtained from the chart by two and then divide this result by the known efficiency. For example, assuming an elevator with a capacity of 3000 pounds, with car speed of 200 feet per minute, and with 1000 pounds over-counterweight. The net load to be lifted will be 2000 pounds. The diagonal line for 2000 pounds cuts the 200 feet-per-minute vertical line at the horizontal line which corresponds to about 25 hp. This will be the size of the motor required if the overall efficiency of the elevator is 50 percent. If 65 percent is the known efficiency, the required horsepower will be less.

$$\text{Horsepower} = \frac{25}{2} \times \frac{1}{.65} = 19.2$$

A 20 hp. motor would consequently be used if the overall efficiency was 65 percent, as assumed.

Starting Torque Requirements

While this formula and the chart provide a reasonably accurate method of obtaining the horsepower rating of the motor for a particular electric elevator installation, it is desirable, especially with alternating-current motors, to consider each motor from the standpoint of its starting torque as well as its horsepower rating. The chart cannot always be depended upon to insure sufficient starting torque.

It is a well-known fact that an elevator requires greater starting torque than is necessary to keep the same elevator running at its rated speed and load. With full rated load on an elevator the effort or torque required to start this load will be, as a rule, from two to two and one-half times as great as the torque required at full load. This is due mainly to static friction, and the exact amount varies with the overall efficiency of the installation. A motor, therefore, to be suitable for elevator work, should be capable of developing from two and one-quarter to three times as much starting torque as is represented by its horsepower rating.

Motor builders do not as yet design all their motors with the same ratio of starting torque to full-load torque. This is particularly true in the case of high-torque squirrel-cage motors, and also to some extent in the case of wound-rotor slip ring motors.

The "inrush" current limitations which are placed on elevator motors by many central stations also cut down the amount of starting torque which could otherwise be obtained.

Squirrel-Cage Motors—In high-torque squirrel-cage motors the increase of torque over that obtained with standard motors is due to the addition of a "fixed" resistor in the rotor circuit. This usually takes the form of high-resistance end rings. The value of this resistor determines the maximum torque that the motor will develop in starting. This resistor also produces the added slip which makes the full-load speed appreciably lower than synchronous or no-load speed. It also cuts down the current inrush when the motor is thrown across the line in starting.

Slip-Ring Motors—The maximum torque which a slip-ring motor will develop is obtained with an external resistor connected in the rotor winding. This maximum torque may be as low as 200 percent of the normal rated full-load torque—a value below that which is necessary for elevator work. It is, therefore, essential that the maximum starting-torque requirements of the motor be known.

Starting Current Inrush—The National Electric Light Association has adopted certain rules which limit the starting-current inrush. The two tables which follow show the maximum current inrush for the various sizes of motors. These tables show the maximum permissible starting-current values for a single motor installed and connected to its load.

Many power companies have already adopted these rules as being reasonable and well within the possibilities of good elevator practice. All power companies should be urged to adopt them, in order to have a universal standard. Some power companies place practically no limitations on starting currents, while others are more rigid in their requirements than the rules of the N. E. L. A. In such cases an unnecessary hardship is placed on the elevator manufacturer and on the owner of the building in which the elevator is installed. As a rule, such stringent regulations can only be met by using an over-sized motor. If the motor is of the squirrel-cage, high-torque type, the addition of a primary resistor on starting will be helpful. This resistor can be short-circuited while running.

Alternating-Current Motors

Polyphase—Sixty Cycles

Hp. of Motor	Line Voltage	*Line Amperes per Phase per Hp.	
		Two Phase	Three Phase
1	220	17.3	20.
1—2	220	15.2	17.5
3—5	220	11.2	13.
	440	5.6	6.5
	550	4.5	5.2
6—30	220	8.	9.
	440	4.	4.5
	550	3.2	3.6
	2200	1.	1.
Above 30	220	5.2	6.
	440	2.6	3.
	550	2.1	2.4
	2200	0.5	0.6

*Current values are those indicated by a suitable well-damped ammeter in the motor circuit on the line side of the starting device, and are 75 percent of the permissible locked-rotor values.

Direct-Current Motors

Shunt and Compound Wound

Size of Motor	Volts	*Amperes Per Hp.
3 Hp. and below......	230	12
	550	5
Above 3 Hp.	230	9
	550	4

*Current values are those indicated by a suitable well-damped ammeter on the line side of the starting resistor.

Starting-Torque Calculations

In order to find the starting torque which an elevator motor will require, it is first necessary to determine the maximum torque requirements of the elevator installation. If possible, it is well to measure this torque by putting full load on the car and determining the actual torque necessary to start the car. This torque is expressed in pounds pull on the motor shaft at a 1-ft radius. If an actual measurement cannot be obtained, the equation below will give very satisfactory results.

$$T = \frac{.8 \times L \times S}{R.P.M.}$$

Where T = pounds torque, at one foot radius on motor shaft, required for starting.
.8 = a constant.
L = net load on the car (unbalanced load) in pounds.
S = speed of car in ft. per min.
R.P.M. = rated full-load speed of the motor (rev. per min.)

In the above calculation the elevator efficiency is assumed to be 50 percent. If the actual efficiency is known to be greater than this value, the torque obtained from the formula may be multiplied by the ratio of 50 percent to the known efficiency. This will give a more nearly accurate torque value. A motor should be selected which has a starting torque which is equal to or greater than the torque obtained by measurement or by the calculation outlined above.

Finally, in selecting an elevator motor, it is essential that it conform to the local power company's rules pertaining to the starting-current limitations.

Motor, Fuse and Wire Ratings

The tables which follow provide a ready reference for those who build or install electrically operated elevators. Tables A, B and C give ratings for direct-current motors, fuses and wires. Tables D, E, F, G, H, J, K, L, M, N, P and Q give similar ratings for alternating-current motors, fuses and wires.

Each motor must be protected by enclosed fuses, one for each line conductor, regardless of whether a circuit-breaker or automatic overload is used or not.

Motors will be considered as being sufficiently protected by the fuses used to protect the conductors of the motor circuits. (Rule 8, National Elec. Code of 1920).

The rated capacity of fuses must not exceed the carrying capacity of conductors. Circuit-breakers or overloads must not be set more than 30 percent above the conductor ratings.

Necessarily the demands of elevator duty require relatively large capacity fuses, especially on alternating-current service. It is desirable therefore to install circuit-breakers or overload relays in addition to the fuses. These may be remotely reset for convenience. This arrangement will not only give better motor protection but will practically prevent any blowing of fuses.

The size of wire for main-line connections and armature and series-field connections are those which are correct for concealed work and are based on moderate lengths of run. For open work, rubber-covered wire may be used in the sizes given under "Other Insulations."

It is assumed that those who use these tables will exercise discretion in their application and will make such modifications as seem necessary for special conditions.

A service knife switch having a pole for each line conductor, and having a current-carrying capacity equal to the maximum size fuse that can be put in the fuse clips must be installed for each motor. This knife switch must have "dead" blades when open and must disconnect the fuses from the line.

Where rubber-covered wire is used in a branch circuit carrying the current of only one alternating-current motor of a type having a large starting current the ratings listed under "Other Insulations" in the tables may be applied to rubber-covered wire.

TABLE A—For 115-Volt Direct-Current Motors

Motor Current, Fuses and Sizes of Connecting Wires

H. P.	Rated Current	Size of Fuse	SIZE OF COPPER WIRE			
			Main Line, Armature and Series Field		Shunt Field Shunt Brake All Insulations	Control Circuits All Insulations
			Rubber Covered	Other Insulations		
1	8	15	No. 12	No. 12	No. 14	No. 14
2	16	25	10	12	14	14
3	24	30	8	10	14	14
5	40	60	4	6	12	14
7½	60	100	1	3	12	14
10	80	125	0	2	12	14
15	120	175	000	0	12	14
20	160	225	0000	00	10	14
25	200	275	300000 C.M.	000	10	14
30	240	325	400000 C.M.	0000	10	14
40	320	450	600000 C.M.	400000 C.M.	10	14
50	400	550	800000 C.M.	500000 C.M.	10	14

TABLE B—For 230-Volt Direct-Current Motors

Motor Current, Fuses and Sizes of Connecting Wires

H. P.	Rated Current	Size of Fuse	SIZE OF COPPER WIRE: Main Line, Armature and Series Field — Rubber Covered	SIZE OF COPPER WIRE: Main Line, Armature and Series Field — Other Insulations	SIZE OF COPPER WIRE: Shunt Field Shunt Brake All Insulations	SIZE OF COPPER WIRE: Control Circuits All Insulations
1	4	7	No. 14	No. 14	No. 14	No. 14
2	8	15	14	14	14	14
3	12	20	12	14	14	14
5	20	30	8	10	14	14
7½	30	50	6	8	14	14
10	40	60	4	6	14	14
15	60	100	1	3	14	14
20	80	125	0	2	12	14
25	100	150	00	1	12	14
30	120	175	000	0	12	14
40	160	225	0000	00	12	14
50	200	275	300000 C.M.	000	10	14

TABLE C—For 550-Volt Direct-Current Motors

Motor Current, Fuses and Sizes of Connecting Wires

H. P.	Rated Current	Size of Fuse	SIZE OF COPPER WIRE: Main Line, Armature and Series Field — Rubber Covered	SIZE OF COPPER WIRE: Main Line, Armature and Series Field — Other Insulations	SIZE OF COPPER WIRE: Shunt Field Shunt Brake All Insulations	SIZE OF COPPER WIRE: Control Circuits All Insulations
1	2	5	No. 14	No. 14	No. 14	No. 14
2	4	7	14	14	14	14
3	6	10	14	14	14	14
5	10	15	14	14	14	14
7½	15	20	12	14	14	14
10	20	30	8	10	14	14
15	30	50	6	8	14	14
20	40	60	4	6	14	14
25	50	70	4	6	12	14
30	60	80	3	5	12	14
40	80	125	0	2	12	14
50	100	150	00	1	12	14

TABLE D—For 110-Volt, Single-Phase Alternating-Current Motors

Primary Current, Fuses and Sizes of Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE: Primary Ciruits — Rubber Insulation	SIZE OF COPPER WIRE: Primary Ciruits — Other Insulations	SIZE OF COPPER WIRE: Brake Solenoid All Insulations	SIZE OF COPPER WIRE: Control Circuits All Insulations
1	14	30	No. 8	No. 10	No. 12	No. 14
2	28	60	4	6	12	14
3	39	80	3	5	12	14
4	31	100	1	3	12	14
5	63	125	0	2	12	14

*The secondary circuit should never be fused, and the size of connecting wires depends entirely on the secondary current of the particular motor.

TABLE E—For 220-Volt, Single-Phase Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	Size of Copper Wire			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	7	15	No. 14	No. 14	No. 14	No. 14
2	14	30	8	10	14	14
3	20	40	6	8	14	14
4	26	50	6	8	14	14
5	32	60	4	6	14	14

TABLE F—For 110-Volt, Two-Phase, Four-Wire, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	Size of Copper Wire			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	7	15	No. 14	No. 14	No. 14	No. 14
2	12	25	10	12	14	14
3	16	30	8	10	12	14
5	28	60	4	6	12	14
7½	38	80	3	5	10	14
10	54	125	0	2	10	14
15	80	175	00	0	10	14
20	104	200	0000	0	10	14
25	129	275	300000 C.M.	000	8	14
30	152	325	400000 C.M.	000	8	14

TABLE G—For 220-Volt, Two-Phase, Four-Wire, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	Size of Copper Wire			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	4	10	No. 14	No. 14	No. 14	No. 14
2	6	15	14	14	14	14
3	8	20	12	14	14	14
5	14	30	8	10	14	14
7½	20	40	6	8	12	14
10	27	60	4	6	12	14
15	40	80	3	5	12	14
20	52	100	1	3	12	14
25	64	125	1	2	10	14
30	76	150	00	1	10	14
40	102	200	200000 C.M.	0	10	14
50	124	275	300000 C.M.	000	10	14

*The secondary circuit should never be fused, and the size of connecting wires depends entirely on the secondary current of the particular motor.

TABLE H—For 440-Volt, Two-Phase, Four-Wire, Alternating-Current Motors

Primary Current, Fuses and Connecting Wire

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	2	5	No. 14	No. 14	No. 14	No. 14
2	3	7	14	14	14	14
3	4.2	10	14	14	14	14
5	7	15	14	14	14	14
7½	10	20	12	14	12	14
10	14	30	8	10	12	14
15	21	40	6	8	12	14
20	27	60	4	6	12	14
25	32	70	4	6	12	14
30	38	80	3	5	12	14
40	51	100	1	3	12	14
50	62	125	0	2	12	14

TABLE J—For 550-Volt, Two-Phase, Four-Wire, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	64	5	No. 14	No. 14	No. 14	No. 14
2	23	5	14	14	14	14
3	3.2	7	14	14	14	14
5	6	15	14	14	14	14
7½	8	20	12	14	12	14
10	12	25	10	12	12	14
15	16	35	8	8	12	14
20	21	40	6	8	12	14
25	27	60	4	6	12	14
30	30	60	4	6	12	14
40	40	80	3	5	12	14
50	50	100	1	3	12	14

*The secondary circuit should never be fused, and the size of connecting wires depends entirely on the secondary current of the particular motor.

TABLE K—Two-Phase, Three-Wire System

†Sizes of Conductor for the Common Wire

H. P.	110 VOLTS		220 VOLTS		440 VOLTS		550 VOLTS	
	Rubber	Other	Rubber	Other	Rubber	Other	Rubber	Other
1	No. 12	No. 14	No. 14	No. 14	No. 14	No. 14	No. 14	No. 14
2	6	8	12	14	14	14	14	14
3	6	8	8	10	14	14	14	14
5	3	5	6	8	12	14	12	14
7½	0	2	4	6	8	10	8	10
10	000	0	3	5	6	8	6	8
15	300000	00	1	3	4	6	4	6
20	300000 C.M.	000	00	1	3	5	4	6
25	500000 C.M.	300000 C.M.	000	0	1	3	3	5
30	600000 C.M.	400000 C.M.	200000	0	0	2	3	3
40	....	....	300000	000	00	1	0	2
50	....	....	300000 C.M.	300000 C.M.	000	0	00	1

†See tables F, G, H and J for sizes of outer wires.

TABLE L—Two-Phase, Three-Wire System

†Size of Fuse for Common Wire

H. P.	110 Volts	220 Volts	440 Volts	550 Volts
1	20	15	7	7
2	40	20	10	7
3	40	30	15	10
5	80	40	20	20
7½	125	60	30	30
10	175	80	40	40
15	275	100	60	50
20	275	150	80	60
25	375	175	100	80
30	450	200	125	80
40	...	275	150	125
50		375	175	150

†See tables F, G, H and J for sizes of fuses for outer wires.

TABLE M—For 110-Volt, Three-Phase, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	8.5	20	No. 12	No. 14	No. 12	No. 14
2	14	30	8	10	12	14
3	19	40	6	8	12	14
5	32	70	4	6	12	14
7½	45	100	1	3	10	14
10	62	125	0	2	10	14
15	93	200	200000 C.M.	0	10	14
20	120	275	300000 C.M.	000	10	14
25	150	325	400000 C.M.	0000	8	14
30	175	400	500000 C.M.	300000 C.M.	8	14

TABLE N—For 220-Volt, Three-Phase, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	4.2	10	No. 14	No. 14	No. 14	No. 14
2	6.8	15	14	14	14	14
3	9.5	20	12	14	14	14
5	16	35	8	8	14	14
7½	22	50	6	8	12	14
10	31	70	4	6	12	14
15	46	100	1	3	12	14
20	60	125	0	2	12	14
25	75	150	00	1	10	14
30	88	175	000	0	10	14
40	116	225	0000	00	10	14
50	144	325	400000 C.M	0000	10	14

*The secondary circuit should never be fused, and the size of connecting wires depends entirely on the secondary current of the particular motor.

TABLE P—For 440-Volt, Three-Phase, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Other Insulations		
1	2.1	5	No. 14	No. 14	No. 14	No. 14
2	3.4	7	14	14	14	14
3	4.7	10	14	14	14	14
5	8	20	12	14	14	14
7½	12	25	10	12	12	14
10	16	35	8	8	12	14
15	23	50	6	8	12	14
20	30	60	4	6	12	14
25	37	80	3	5	12	14
30	44	100	1	3	12	14
40	59	125	0	2	12	14
50	73	150	00	1	12	14

TABLE Q—For 550-Volt, Three-Phase, Alternating-Current Motors

Primary Current, Fuses and Connecting Wires

H. P.	Primary Current Per Phase	*Primary Fuses	SIZE OF COPPER WIRE			
			Primary Circuits		Brake Solenoid All Insulations	Control Circuits All Insulations
			Rubber Insulation	Others Insulations		
1	1.6	5	No. 14	No. 14	No. 14	No. 14
2	2.7	7	14	14	14	14
3	3.8	10	14	14	14	14
5	7	15	14	14	14	14
7½	9	20	12	14	12	14
10	13	30	8	10	12	14
15	19	50	8	8	12	14
20	24	50	6	8	12	14
25	30	60	4	6	12	14
30	35	70	4	6	12	14
40	47	100	1	3	12	14
50	58	125	0	2	12	14

* The secondary circuit should never be fused, and the size of connecting wires depends entirely on the secondary current of the particular motor.

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